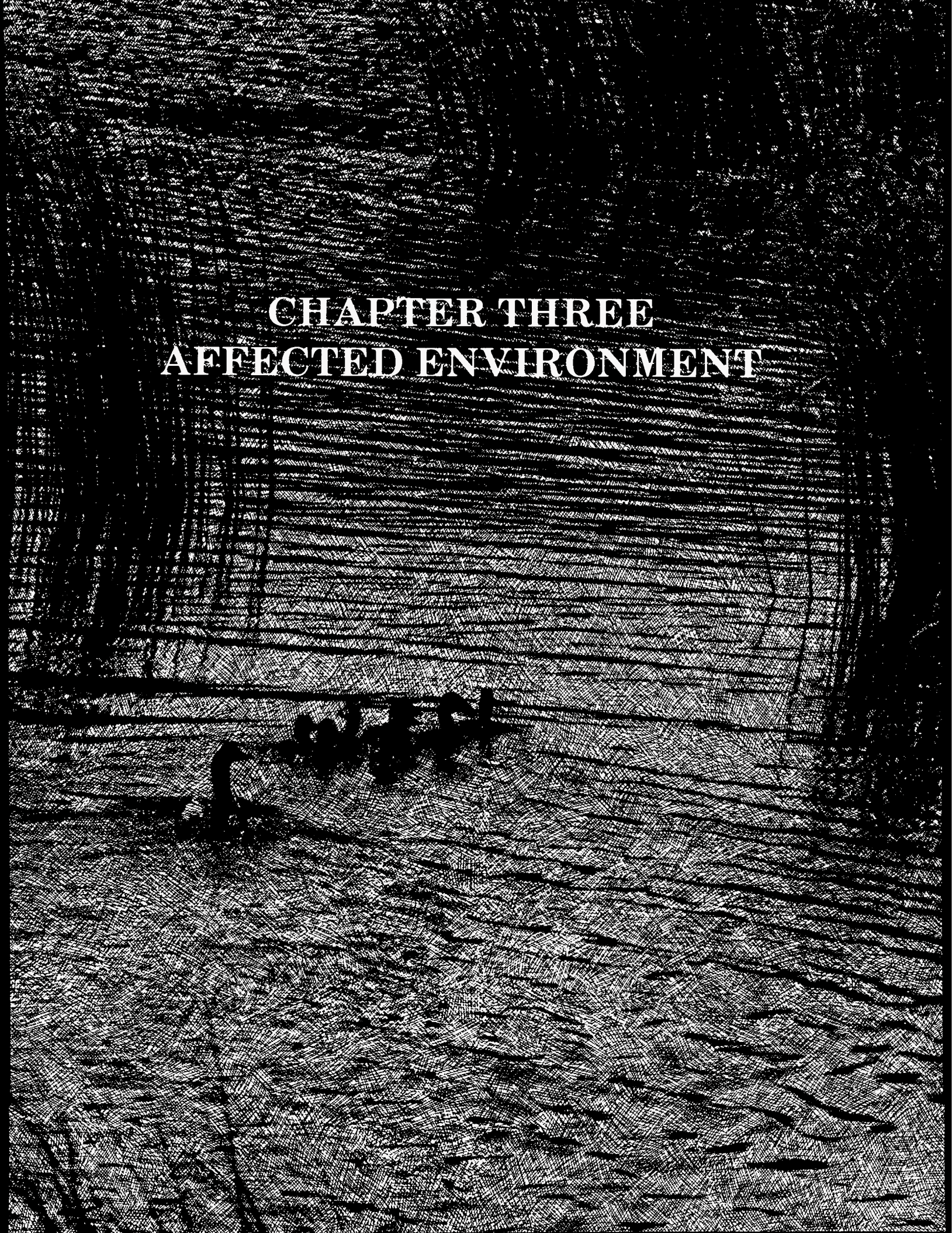


CHAPTER THREE
AFFECTED ENVIRONMENT

CHAPTER THREE
AFFECTED ENVIRONMENT

CLIMATE AND AIR QUALITY

Climate

The climate of North Dakota is semiarid to continental. Air masses causing changes in the weather originate in the Arctic, Gulf of Mexico, and the Northern Pacific. There are no topographical barriers to modify the flow of cold, dry air masses from polar regions and warm, moist air masses from tropical regions. There are often large and rapid changes in weather conditions over the state.

Temperatures throughout North Dakota fluctuate widely on an annual, seasonal, and daily basis. Annual mean temperatures range from 37°F in the northeast to about 43°F in the southwest. Temperature extremes can range from below -40°F to over 110°F. Average July temperature is about 69°F and average January temperature is 10°F.

Average annual precipitation varies from 13 inches in the northwest to about 20 inches in the east (Figure 3-1) with up to 70 percent of precipitation falling as rain between May and July. Precipitation is mainly derived from air masses originating from the Gulf of Mexico. Winters are long and cold with snow accumulations from November or December through March.

Windy conditions are common due to the greatly fluctuating temperatures and lack of physical barriers. Prevailing winds are from the north-northwest at an average speed of 12 miles per hour (mph). Winds of 25-30 mph will often last for 6 hours and can last as long as 15 hours. Winds in excess of 30 mph have lasted more than 6 hours.

Severe weather may occur almost any time during the year. Blizzards are a common occurrence during winter and early spring. High winds and hail frequently occur in connection with summer thunderstorms.

Air Quality

Data indicate the general air quality of North Dakota is good with localized areas in the Williston Basin showing incidences of noncompliance with State and National AAQS. Noncompliance is presumably caused by the burning of fossil fuels and flaring of gas during energy production or development are the primary sources of contamination in western North Dakota.

The NDSDH is responsible for monitoring air quality. Their network of monitoring stations provides air quality data to: (1) determine background levels of pollutants such as total suspended particulates (TSP), SO_2, and H_2S, (2) determine highest concentration of pollutants in area, and (3) determine impacts of these pollutants from nearby significant sources. NDSDH has monitoring sites near several of the major coal areas which include stations in the vicinity of Mandaree, Theodore Roosevelt National Park — North Unit, Lone Butte, and Dunn Center.

The three major pollutants measured by the NDSDH are pertinent due to increased development of oil, gas, and coal. H_2S is emitted in major quantities from the oil and gas fields. SO_2 results from the flaring (burning) of the gas containing H_2S and from the burning of fossil fuels in facilities such as coal-fired power plants. These gases create health and safety hazards, offensive odors, and contribute to air quality problems such as acid rain. TSP results from fugitive dust of coal mining and burning of fossil fuels. Haul roads and construction activities are also major sources of fugitive dust. Increased levels of TSP may affect visual quality and can aggravate respiratory ailments.

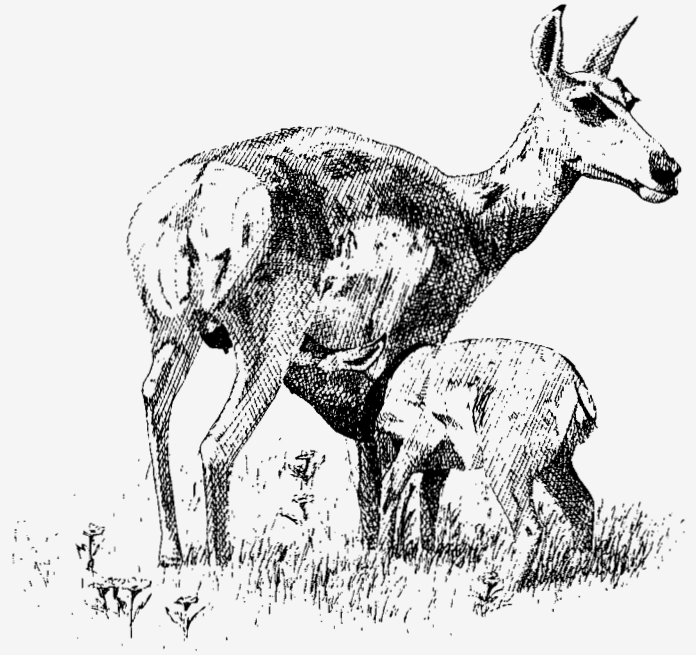
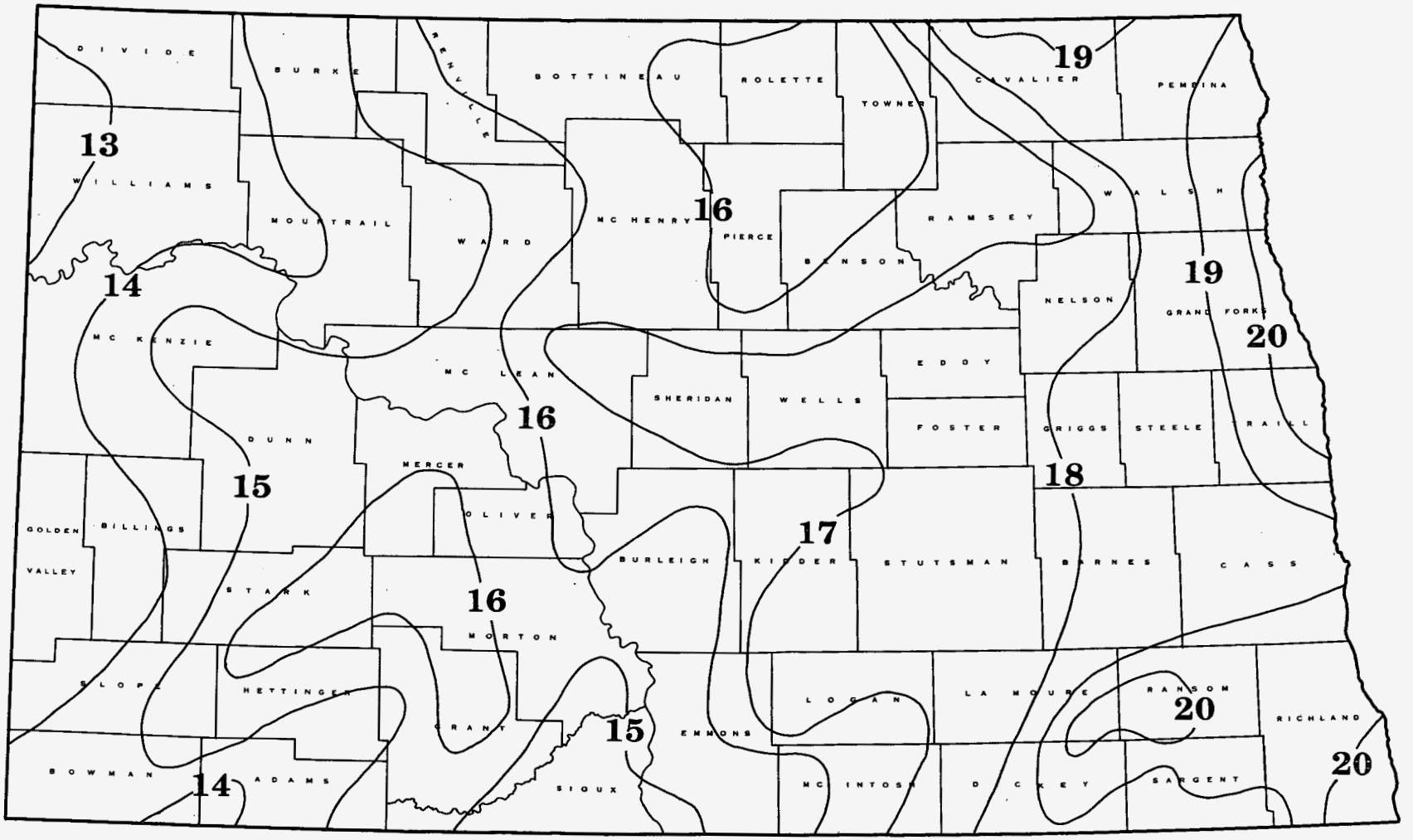


Table 3-1 shows the concentrations of the three pollutants from several of the monitoring sites for 1984. The Lone Butte site is centrally located in an oil and gas development field of high H_2S concentration (approximately 20 percent by volume). The monitoring site is virtually surrounded by point sources emitting both H_2S gas and SO_2 from the flaring of the H_2S gas. The Theodore Roosevelt National Park-North Unit and Dunn Center monitoring sites are in fairly remote areas relatively free of direct point source contamination. Comparison between the monitoring site results and the AAQS (Table 3-2) indicates violations of those standards occur as a localized problem associated with specific oil and gas development sources. Modeling of the immediate sources would further refine the localized air quality impacts caused by near sources. However, further regional studies are necessary to analyze and isolate the areas of development that may be causing violation of the standards.

Air quality standards applicable to pollutant sources in the oil and gas fields are those resulting from the Federal Clean Air Act and the North Dakota Pollution Control Act. Selected North Dakota AAQS and the National AAQS are listed in Table 3-2. The National AAQS are expressed as both primary and secondary standards. Primary standards are those required, with an adequate margin of safety, to protect public health. Secondary standards are those necessary to protect the public welfare from any known or anticipated adverse effects associated with air pollutants.

FIGURE 3-1



Annual mean precipitation in North Dakota in inches (Climate of North Dakota, North Dakota National Weather Service, NDSU, Fargo, ND, based on 1931-1960).

TABLE 3-1
1984 POLLUTION DATA SUMMARY

Pollutant	Location	No. of Observations	1-Hour Maximum Concentration (ug/m³) 1st Observ.	1-Hour Maximum Concentration (ug/m³) 2nd Observ.	3-Hour Maximum Concentration (ug/m³) 1st Observ.	3-Hour Maximum Concentration (ug/m³) 2nd Observ.	24-Hour Maximum Concentration (ug/m³) 1st Observ.	24-Hour Maximum Concentration (ug/m³) 2nd Observ.	AMC* (ug/m³)
Sulfur Dioxide	Dunn Center	8,231	76	73	57	55	24	19	4
SO_2	TRNP-N[1]	8,263	105	94	92	92	78	29	4
	Lone Butte	8,049	1,038	1,003	786	723	311	259	31
Hydrogen	TRNP-N[1]	16,169	581	570	—	—	—	—	4
Sulfide (H_2S)	Long Butte	16,532	3,542	2,705	—	—	—	—	60

Pollutant	Location	No. of Observations	24-Hour Maximum Concentration (ug/m³) 1st Observ.	24-Hour Maximum Concentration (ug/m³) 2nd Observ.	24-Hour Maximum Concentration (ug/m³) 3rd Observ.	Annual Geometric Mean (ug/m³)	AMC* (ug/m³)
Total Suspended Particulate (TSP)	Mandaree	53	102	96	78	25	31
	Dunn Center	56	117	106	69	19	26
	TRNP-N	51	239	94	89	23	36

[1]Theodore Roosevelt National Park-North Unit.
*Arithmetic Mean Concentration

TABLE 3-2
NORTH DAKOTA AND NATIONAL AIR QUALITY STANDARDS FOR SELECTED POLLUTANTS

Pollutant	North Dakota Standard	Federal Primary Standard	Federal Secondary Standard
Total Suspended Particulates	60 ug/m³ annual geo. mean. 150 ug/m³ 24-hr average[1]	75 ug/m³ annual geometric mean 260 ug/m³ 24-hr average[1]	60 ug/m³ annual geometric mean 150 ug/m³ 24-hr average[1]
Sulfur Dioxide	60 ug/m³ annual average 260 ug/m³ 24-hr average 715 ug/m³ ppm 1-hr average[1]	80 ug/m³ annual average 365 ug/m³ 24-hr average[1]	1300 ug/m³ 3 phr average[1]
Nitrogen Dioxide	100 ug/m³ annual average 200 ug/m³ 1-hr average	100 ug/m³ annual average	100 ug/m³ annual average
Hydrogen Sulfide	45 ug/m³ 1/2-hr average[2] 75 ug/m³ 1/2-hr average[2]	None None	None None

[1]Not to be exceeded more than once per year.
[2]Not to be exceeded more than twice in any five days.

Standards apply only to facilities accessible by surface owners, industry employees, or general public.

The AAQS are also established to protect public health and welfare. The state standards must be as stringent as the federal standards but may be more strict if the state so decides.

Under the 1977 Federal Clean Air Act Amendments, states were required to classify areas as: (1) attainment areas where air quality is better than National AAQS, (2) nonattainment areas where air quality concentrations exceed National AAQS, and (3) unclassified areas where there was insufficient data to classify the area. There are no "nonattainment areas" established in North Dakota.

The one-hour standard for SO_2 was exceeded nine times at the Lone Butte site. The three-hour federal standard was not exceeded. The 24-hour standard was exceeded once at the Lone Butte site and the annual standard was not exceeded.

No state or federal standards were exceeded at either the Dunn Center or Theodore Roosevelt National Park-North Unit Monitoring Stations. Comparison with other time average standards shows that no concentration values exceed these percentages.

Average hourly concentrations and mean monthly concentrations of SO_2 are typically greatest during the wintertime when the atmospheric mixing height is reduced and both atmospheric stability and fumigation frequency (plume contacts the ground) are increased. At each of the three monitoring stations the highest recorded levels of SO_2 are associated with infrequently occurring calm or light wind conditions.

Several major H_2S gas producing oil fields are situated to the east and to the south of Theodore Roosevelt National Park and undoubtedly account for much of the measured SO_2. H_2S emission appears to be a greater problem in geographical extent and number of violations of standards than SO_2 emission. While apparently not a region-wide problem, H_2S concentrations exceeded standards at both the Theodore Roosevelt National Park-North Unit site and the Lone Butte site. The state half-hour standard was exceeded 2,834 times at the Lone Butte site and 34 times at the Theodore National Park-North Unit site. The highest recorded value was at the Lone Butte site at a concentration of 3,542 ug/m³.

The H_2S standard maximum half-hour concentration was exceeded 3,575 times at the Lone Butte site and 85 times at the Theodore Roosevelt National Park-North Unit site. This demonstrates the influence of a major sour gas-producing field overlapping the Dunn-McKenzie county line. Presently, the State Department of Health is meeting with the oil and gas operators in the Lone Butte Field to establish action plans which would implement measures to bring the field into compliance with the H_2S AAQSs. NDSDH is the lead agency for any enforcement actions should voluntary compliance measures fail.

Total Suspended Particulates

Only one sample exceeded the state TSP 24-hour standard. However, since one exceedance is permitted per year there were no violations of the TSP standard. Local sampling near coal mines may show exceedances of the AAQS and possible consumption of increment for Prevention of Significant Deterioration (PSD).

The PSD program allows a specific increase of an air pollutant above an existing baseline air quality. The incremen-

tal increase depends on the area's designation as a Class I, II, or III area (Table 3-3).

Class I areas are allowed the smallest increase from future degradation of air quality. Mandatory Class I areas are national parks over 6,000 acres and national wilderness areas over 5,000 acres. In North Dakota the Theodore Roosevelt National Park and the Lostwood National Wildlife Refuge are classified as Class I areas. The rest of North Dakota is designated Class II. Class II areas are designated for a moderate increase in new sources and air pollution concentrations. Areas that are designated for a lesser degree of protection from future degradation are Class III areas. In these areas significant increases in new pollution may be permitted. There are no Class III areas in the nation.

TABLE 3-3
FEDERAL AND STATE PSD INCREMENTS

Deterioration Increments for Area Designations	Increments (ug/m³) Federal	North Dakota
Particulates		
Class I		
annual geometric mean	5	5
24-hour maximum	10	10
Class II		
annual geometric mean	19	19
24-hour maximum	37	30
Class III		
annual geometric mean	37	37
24-hour maximum	75	75
Sulfur Dioxide		
Class I		
annual arithmetic mean	2	2
24-hour maximum	5	5
3-hour maximum	25	25
Class II		
annual arithmetic mean	20	15
24-hour maximum	91	91
3-hour maximum	512	512
Class III		
annual arithmetic mean	40	40
24-hour maximum	182	182
3-hour maximum	700	700

Recent studies of the Bear's Den oil and gas field indicate that the Class II increment could be consumed if further development in that area occurs. Other areas of oil and gas development could show similar consumption of the Class II increment.

Other studies such as the Fort Union Coal EIS (USDI 1982) indicate that similar consumption of the SO_2 increment over the Theodore Roosevelt National Park Class I area could have occurred and the Class II TSP increment near coal mines could be consumed under certain meteorological conditions.

Oil and gas development in the planning area includes fields established by the North Dakota Industrial Commission. Fields outside the USFS planning boundary have shown lower H_2S concentrations. The larger, more developed fields like the Lone Butte field are within the USFS boundary and have very high concentrations of H_2S. Wells containing up to 18 percent H_2S (180,000 ppm) are not uncommon. However, the fields within the planning area tend to average between 0.5 percent (5000 ppm) to 3.5 percent (35,000 ppm) H_2S from the Mission Canyon producing zone. A recent air quality study of the Bear's Den and Croff fields indicates that existing wells in the fields are violating the AAQSs and have consumed the Class II PSD increment.

MINERALS

The major elements of the economically viable mineral resources in North Dakota are coal, oil, and gas. The following discussion highlights these resources and briefly details other saleable federal minerals in the state.

Coal

This document analyzes 24 CSAs. The CSAs are located in approximately the western one-third of the state (Map 3-1, map packet). The CSAs analyzed in this RMP differ from those in earlier land use plans. Changes include combining previous CSAs, changing names, changing acreages, and adding new CSAs (Table 3-4). Table 3-5 presents the acreage of federal and nonfederal coal for each CSA.

The CSAs represent areas with known development potential based on seam thickness, depth of seam, and stripping ratios. An explanation of development potential is provided in Appendix B.

TABLE 3-4
RELATIONSHIP BETWEEN CSAs DEFINED IN PREVIOUS LAND USE PLANS AND CURRENT CSAs

Previous CSA	Acres Fed. Coal	Current CSA	Acres Fed. Coal
Hazen	3,200	Antelope	32,360
Renner's Cover	17,900		
North Beulah	2,838		
Bennie Peer	11,600	Arnegard	25,020
South Beulah	9,529	Beulah-Zap	57,200
Zap	3,884		
Bowman-Gascoyne	21,320[1]	Bowman-Gascoyne	21,320
Center-Stanton	12,895	Center-Stanton	27,480
Dickinson	78,924	Dickinson	108,628
Dunn-Center	41,550	Dunn Center	88,560
Elgin-New Leipzig	14,400[1]	Elgin-New Leipzig	14,400
Garrison	8,808	Garrison	12,660
Golden Valley	11,794	Golden Valley	21,960
Hanks	47,100[1]	Hanks	47,100
Keene	—[2]	Keene	122,700
Mott	42,200[1]	Mott	42,200
New England	95,800[1]	New England	95,800
Sand Creek	57,240[1]	Sand Creek	57,240
Tobacco Garden	32,920	Tobacco Garden	64,060
Underwood	1,430	Underwood	2,600
Washburn	1,035	Washburn	1,360
Williston	98,020[1]	Williston	98,020
		Divide	3,760
		Elkhorn	25,380
		Fortuna	19,400
		Niobe	160
		Velva	20,280

[1]These values are corrected from original MFP acreages to account for existing federal coal leases, mapping errors, and other inconsistencies.

[2]The Keene deposit was dropped from consideration for coal leasing before completion of the McKenzie-Williams MFP. No acreage figure was reported.

TABLE 3-5
COAL STUDY AREA ACREAGES

CSA	Coal Acreages		
	Nonfederal	Federal	Total
Antelope	111,880	32,360	144,240
Arnegard	10,560	25,020	35,580
Beulah-Zap	108,680	57,200	165,880
Bowman-Gascoyne	63,296	21,320	84,616
Center-Stanton	121,680	27,480	149,160
Dickinson	307,040	108,628	415,668
Divide	49,640	3,760	53,400
Dunn Center	139,500	88,560	228,060
Elgin-New Leipzig	31,400	14,400	45,800
Elkhorn	5,040	25,380	30,420
Fortuna	10,920	19,400	30,320
Garrison	70,500	12,660	83,160
Golden Valley	50,148	21,960	72,108
Hanks	57,680	47,100	104,780
Keene	40,720	122,700	163,420
Mott	93,320	42,200	135,520
New England	172,400	95,800	268,200
Niobe	10,200	160	10,360
Sand Creek	117,530	57,240	174,770
Tobacco Garden	13,360	64,060	77,420
Underwood	27,760	2,600	30,360
Velva	112,400	20,280	132,680
Washburn	33,800	1,360	35,160
Williston	87,160	98,020	185,180
Totals	1,846,614	1,009,648	2,856,262

Coal beds of economic interest in North Dakota are in the Tongue River and Sentinel Butte Members of the Fort Union Formation (Paleocene in age, about 60 MM years old). Three other units (the Ludlow Member in the lower Fort Union, Golden Valley Formation above the Fort Union, and Hell Creek Formation below) contain coal which is too thin, impure, and discontinuous to be of economic value.

The Tongue River Member is about 350 to 900 feet thick. It is made up of alternating layers of sandstone, siltstone, claystone, limestone, and lignite coal (Rehbein 1977; Royse 1967, 1971). The Sentinel Butte Member is likewise made of sandstone, siltstone, claystone, limestone, and coal. It contains slightly more sandstone than the Tongue River Member (Jacobs 1976).

Overburden, the sediments above the coals of interest for mining, consists of the sandstones, siltstones, and claystones of the Tongue River and Sentinel Butte Members and the Golden Valley and White River Formations, and the silts and gravels of the Coleharbor, Walsh, and Oahe Formations. These last three are alluvial and glacial deposits capping the upland surfaces and lining river valleys.

The coal beds of the Fort Union range in thickness from thin films to a reported 37 feet. Generally, only beds at least five feet thick are considered to be of interest. North Dakota mines usually remove from 4 to 20 feet of coal from one to four beds.

North Dakota coal is ranked as lignite. Its heating value ranges from 5,000 to 7,500 British thermal units per pound (Btu/lb). North Dakota coal typically has moisture content ranging from 33.0 to 44.0 percent, ash 4.0 to 19.0 percent, and sulfur content 0.2 to 2.4 percent.

The coal resources of North Dakota have been estimated at various times. Brant (1953) estimated 351 billion tons. Averitt (1971) identified 15 billion tons of this to be strippable in beds greater than five feet thick and under less than 100 feet of overburden. The constant acquisition of new data allows continual refinement of these estimates. The resources identified in the current study areas total 44.2 billion tons for North Dakota (Appendix B).

Ten mines in North Dakota produced a total of 25.4 MM tons of coal in the year ending June 30, 1985. One mine transports coal by rail out of state. A second mine sends part of its production out of state. Another processes weathered lignite (leonardite) for fertilizer, cosmetics, and oil and gas drilling mud additives. The remaining mines support either mine-mouth electric power and synfuel facilities, or power plants in the vicinity.

Eight of these mines hold 20 federal coal leases. Three of these 20 leases are mined out, leaving 17 active, minable leases (Appendix O). There are 235 MM tons of recoverable coal left in these leases. There are about 17,000 acres of federal coal under lease.

Oil and Gas

Oil and gas exploration and development in North Dakota has been concentrated in the western third of the state in the area generally referred to as the Williston Basin. The Williston Basin covers approximately 200,000 square miles of western North Dakota, northwestern South Dakota, eastern Montana, southern Saskatchewan, and extreme southwestern Manitoba.

The majority of oil and gas production in North Dakota can be found in Williams, Billings, and McKenzie Counties. The following are also oil and gas producing counties: Divide, Burke, Renville, Bottineau, Hettinger, Ward, McLean, Mountrail, Bowman, Dunn, Golden Valley, Stark, Slope, Mercer, and McHenry.

In 1984 a Memorandum of Understanding (MOU) between BLM and USFS covering oil and gas operations within the Little Missouri National Grasslands was put into operation. This facilitated surface management involving 771 producing federal wells falling within the grasslands boundary. Of North Dakota's 412 producing oil and gas fields 93 also fall within this boundary. USFS personnel act as BLM's agent at on-site inspections within the grasslands while BLM retains all subsurface authority, approval, inspection, and enforcement responsibilities.

As of October 1985, a total of 10,695 wells have been drilled in North Dakota. These wells vary in depths from less than 2000 feet in gas wells in the Eagle Member of the Pierre formation in Bowman County to greater than 13,000 feet in oil wells in the Red River formation in Bowman, Billings, and McKenzie Counties.

Exploration and development of oil and gas is generally characterized in three categories: (1) development drilling, (2) wildcat drilling, and (3) extension drilling. The number of wells that have been drilled through the end of calendar year 1984 include:

	Producers	*Dry*
Development	3901	1240
Wildcat	466	2731
Extension	845	823

Source: NDIC 1985

Federal and Indian wells contained in this tally include 600 active oil wells, 24 active gas wells, 32 shut-in oil wells, 7 shut-in gas wells, 70 injection/disposal wells, 225 abandoned or temporarily abandoned wells, and 196 plugged and abandoned wells.

Total number of federal oil and gas leases in effect in North Dakota as of September 30, 1984, was 1,894. These leases encompassed about 1.4 MM acres (Appendix O). Development of these leases and acres of mineral land has varied since 1951 and is directly tied to the price of oil.

Other leaseable and locatable minerals in the District are sodium, sodium chloride, potassium, uranium and bentonite. Sodium deposits are generally in Adams, Hettinger, Stark, and Oliver counties. Potassium is found in McKenzie, Dunn, Mountrail, Ward, and Renville counties. The major surface deposits of uranium and bentonite are found in Bowman County. Historically there has been limited demand in the District for these minerals.

Saleable Minerals

Scoria and sand and gravel are the major saleable minerals found in the District. Most scoria and sand and gravel deposits are privately owned.

Scoria deposits are the result of the baking of overlying rock by burning coal beds. Scoria is associated with most lignite occurrences in western North Dakota. The most visible and accessible deposits tend to be in southwestern North Dakota. The largest concentrations of sand and gravel are glacial moraine deposits located in a 12 to 15 mile wide strip along the north side of Lake Sakakawea in a northwesterly direction from Bismarck. Other concentrations are in the Mercer County area and in the northeastern corner of the state. Smaller, more localized alluvial fans and terrace deposits occur along most stream and river channels and abandoned channels.

There is some undeveloped demand for federally-reserved saleable minerals in the District. Although material requirements largely are being met by private sources, cases of unauthorized use that have taken place in the last ten years indicate a demand for federally reserved saleable minerals.

TOPOGRAPHY AND SOILS

Coal Study Areas

The CSAs in the unglaciated prairie region in the southwestern portion of the state have topography that primarily consists of low, smoothly-rounded hills with long, gentle to moderate slopes (3-9 percent) and a well-defined system of branching drainageways. There are hills and buttes scattered across those CSAs which rise abruptly from the surrounding landscape with hilly and steep slopes (15-30 percent). The soils have primarily formed in place from shale and sandstone (Morton, Cabba, Vebar, Rhoades, Regent).

CSAs in the west-central part of the state lie in an area covered with drift remnants of glacial till. Topography in these CSAs is undulating to strongly rolling (3-15 percent slopes) with extensive areas of hilly and steep slopes (greater than 15 percent) along Lake Sakakawea (Missouri River breaks) and some of the tributaries of the Missouri River, (e.g., Knife River). These soils have formed in shale and sandstone (Cabba, Morton), alluvium in potholes and depressions (Parnell, Tonka), and glacial till (Williams, Bowbells, Zahl).

A few of the north and northeastern CSAs lie along the Missouri River couteau and the till plain of the glaciated prairie and prairie pothole region. These CSAs have rolling topography (3-15 percent slopes) characterized by low, moderately sloping, irregularly-shaped hills with areas of gentle slopes, a few steeper knobs, occasional drainageways and some depressions containing marshes, ponds, and poorly-drained soils (Parnell, Tonka). There are hilly and steep areas (15-30 percent slopes) along major drainageways (coulees) and on portions of the Missouri couteau. Soils are derived from loamy glacial till (Williams, Noonan, Bowbells, Zahl).

Reclamation Potential

The Soil Conservation Service (SCS) Land Capability Classes (LCCs) were used to determine reclamation potential. Capability classes show, in a general way, the suitability of soils for most kinds of field crops or for mechanical treatments. The soils are classed according to their limitations when they are used for field crops, the risk of soil and vegetation damage when they are used, and the way they respond to treatments.

Capability classes are designated by numerals I through VIII. The numbers indicate progressively greater use limitations. The following is a brief description of the LCCs:

Classes I, II and III — These soils generally have high potential for reclamation. They are suited for cultivation, pasture, woodland, range or wildlife food and cover.

Class IV — These soils generally have moderate potential for reclamation. They are marginal for cropland, but are suited for hayland, pasture, woodland, range or wildlife food and cover.

Class V — These soils have a variable potential for reclamation. They are nearly level, wet, stoney, have severe climatic limitation, or some combination of the above. Because of these limitations cultivation of crops is infeasible but Class V soils may provide pastures.

Class VI — These soils have moderate potential for reclamation, depending upon the chemical and physical properties of the soil. They are generally unsuited for cultivation and are best suited for pasture or range, woodland or wildlife food and cover.

Class VII — These soils have low potential for reclamation because of the chemical and physical properties of the soils and the rugged topography on which they are found. They are limited largely to grazing, woodland, or wildlife.

Class VIII — These soils and landforms are generally unsuited for reclamation, because of the chemical and physical properties of the soils and the rugged topography on which they are found. These are best suited for watershed protection, recreation, wildlife or aesthetic purposes.

The reclamation potential of the CSAs as it pertains to restoring agricultural and rangeland productivity is generally high (Table 3-6). About 48 percent of the surface over federal coal in the CSAs is dominated by soils in LCCs II and III. About 24 percent has hilly and steep slopes greater than 15 percent and falls into LCCs VII and VIII. The largest areas of slopes greater than 15 percent are in the Williston and Tobacco Garden CSAs.

TABLE 3-6
RECLAMATION POTENTIAL[1]

Probable Reclamation Success	Mapping Units[2]	Slope Class Percent	Acres and Percent of Surface Over Federal Coal Represented	Dominant Land Capability Classes (LCCs)
High	Chama-Cabba	6-9	481,960	
	Cresbard	0-3	(48%)	
	Flaxton	3-6		I, II, III
	Golva-Chama	3-6		
	Morton	3-6		
	Morton-Cabba	6-9		
	Morton-Regent	3-6		
	Vebar	3-9		
	Vebar-Williams	3-9		
	Williams	0-6		
	Williams-Cresbard	0-3		
	Williams-Zahl	6-9		
Moderate	Cabba-Morton	9-15	282,701	
	Cabba-Morton-Rhoades	9-15	(28%)	IV, V, VI
	Morton-Rhoades	0-9		
	Regent-Rhoades	3-6		
	Rhoades	3-6		
	Wabek-Lehr	6-9		
	Zahl-Cabba	9-15		
	Zahl-Williams	9-15		
Low	Cabba	15-30	244,987	
	Cabba-Badland	30+	(24%)	
	Cabba-Flasher	15-30		VII, VIII
	Flasher-Vebar	15-30		
	Zahl	15-30		
	Zahl-Cabba	15-30		
	Zahl-Flasher	15-30		

[1]Reclamation potential is determined by the soil profile to 60 inches.
[2]Mapping from Soil Survey Report (Patterson et al. 1968).

Surface Lands

Big Gumbo Area

Much of the area is on the Cedar Creek anticline, which is characterized by a dissected landscape dominated by low, rounded hills. The southern edge of the area has numerous flat-bottomed gullies and irregularly shaped "blowouts" with sandy hummocks formed by wind.

The soils of the area are dominated by the Dilts and Lisam series. Both these soils have formed in soft, crumbly Pierre shale. They are clayey, well drained, shallow soils with low inherent fertility. The Dilts soil is acidic whereas Lisam is neutral to moderately alkaline. Soils on the southern edge of the area have formed in the Fox Hill formation. These are mostly sandy soils such as Ekalaka, Zeona and Ladner. They are moderately deep, well drained, alkali, and have rather low available water capacity, and low to medium inherent fertility.

Lost Bridge Area

About two-thirds of the management area is badlands or steep terrain (greater than 30 percent); five to ten percent has nearly level slopes (0-3 percent), primarily along the Little Missouri River. The remaining area varies from gently sloping to hilly and steep (3-30 percent slopes).

Soils in the area along the Little Missouri River are primarily covered by the Banks-Trembles-Havrelon soil mapping unit. These three soil series are on nearly level to gently sloping (0-6 percent) sites. They are well and somewhat excessively drained, deep, coarse, moderately coarse, and medium-textured soils formed in recent alluvium.

Public lands on the uplands are primarily covered by the Cabba-Badland-Cherry-Arikara soil mapping unit. These soils and badlands are found on slopes ranging from nearly level to very steep (1-120 percent). They are well and excessively drained, shallow to deep, medium and moderately fine-textured soils formed in weathered soft bedrock, local alluvium, and colluvium.

Scattered Tracts

In the unglaciated southwestern portion of the state, most of the tracts are covered by sodic claypan soil (Rhoades) on nearly level slopes, shallow soils on steep slopes (Cabba, Flasher), and badland areas with numerous outcrops of shale and sandstone.

Soils on scattered tracts in the semi-glaciated region near Lake Sakakawea are often located in rough "breaks." They are dominated by shallow soils (Cabba, Flasher) formed in shale and sandstone and deep soils with poor development formed in remnants of glacial till (Zahl). There are also areas of exposed shale and sandstone due to the highly erosive nature of these steep areas.

Scattered tracts north and east of the Missouri River in the glaciated prairie and prairie pothole region are covered by soils formed in glacial till (Max, Williams, Zahl), alluvial material around ponds, potholes, and marshes (Lallie, Parnell, Tonka, Ojata), and glacial lake and outwash sediments (Hecla, Maddock, Serden). Those tracts with soils formed in glacial till are often hilly (15-30 percent slopes) and covered by stones.

Other Mineral Estate

Federal minerals are located mainly in the western one-third of the state. Topography consists of nearly level to

rolling glacial till plains in the north with areas of potholes and marshes; rugged Missouri River breaks around Lake Sakakawea in the west-central part of the state; steep, highly dissected sedimentary uplands (badlands) along the Little Missouri River in the west; and gently to strongly sloping unglaciated sedimentary plains in the southwest with isolated steep hills and buttes rising above the general landscape.

Soils consist of deep loams and clay loams derived from glacial till in the north (Williams, Bowbells, Zahl). The west-central portion has the same soils from glacial till as just mentioned and also those derived from sedimentary shales and sandstones (Cabba, Flasher, Morton). Much of this area is highly erosive because of the Missouri and Little Missouri Rivers. The southwestern portion of the state is unglaciated with soils derived from the underlying shales and sandstones and also alluvium. Many of the soils are moderately deep (Morton, Regent, Vebar, Chama) with some shallow (Cabba, Flasher) and deep (Rhoades, Golva) also present.

HYDROLOGY

Surface Water

The Missouri River, Lake Sakakawea, and Lake Oahe are the most significant sources of surface water in North Dakota. Streamflow of the Missouri River is equal to or greater than 11,700 cubic feet per second (cfs) 90 percent of the time at Bismarck, North Dakota. The mean annual flow of the Missouri River at Bismarck, North Dakota, is 17,220,000 acre-feet, which is more than 80 percent of the state's total measured annual streamflow (Winter et al. 1984).

Major tributaries of the Missouri River include the Little Missouri, Knife, Heart, and Cannonball Rivers. Average annual runoff will vary from one-fourth to one inch throughout North Dakota (Figure 3-2).

The major constituents affecting the quality of water in the Missouri River mainstem (including Lake Sakakawea and Lake Oahe) are sodium, magnesium, calcium, sulfate, and bicarbonate. Total dissolved solid concentrations range from 300-600 milligrams per liter (mg/l). Water from the Missouri River is suitable for public supply, domestic uses, and irrigation uses.

Tributaries of the Missouri River usually have peak flows in response to snowmelt runoff and summer storms. These waters are of poorer quality and have total dissolved solids ranging between 500-2500 mg/l. Water from the Missouri River tributaries are marginally suitable for public supply, domestic supply, and marginal to unsuitable for irrigation use.

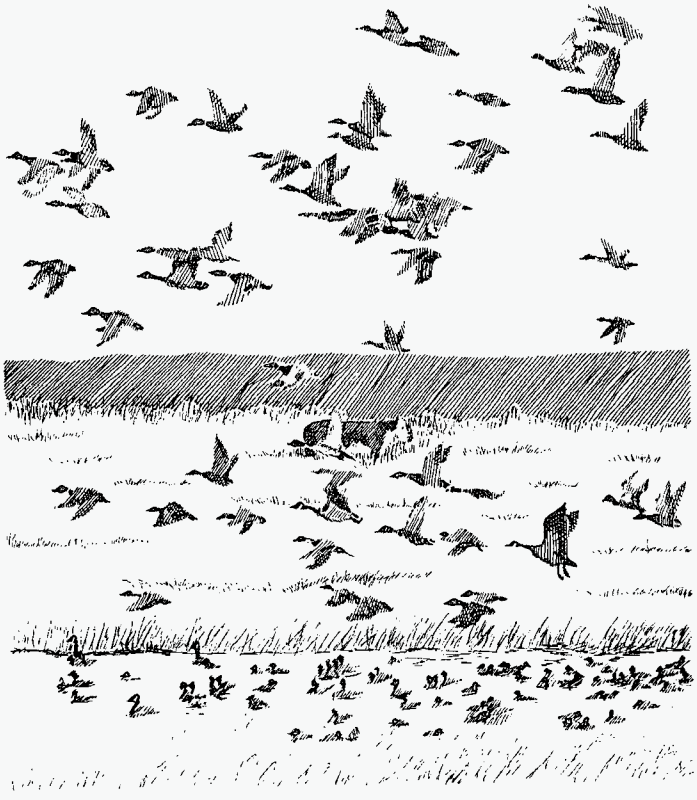
The state can be divided into six general areas according to surface drainage characteristics (Figure 3-3). The Badlands are characterized by a very dense drainage network with stream channels deeply cut into easily-eroded sandstone and shale beds. Slopes are steep and vegetative cover varies from good to none. These conditions lead to streamflows that respond quickly to rain and snowmelt events. Streams and rivers formed in the Badland hydrology area may carry large amounts of dissolved solids and sediments.

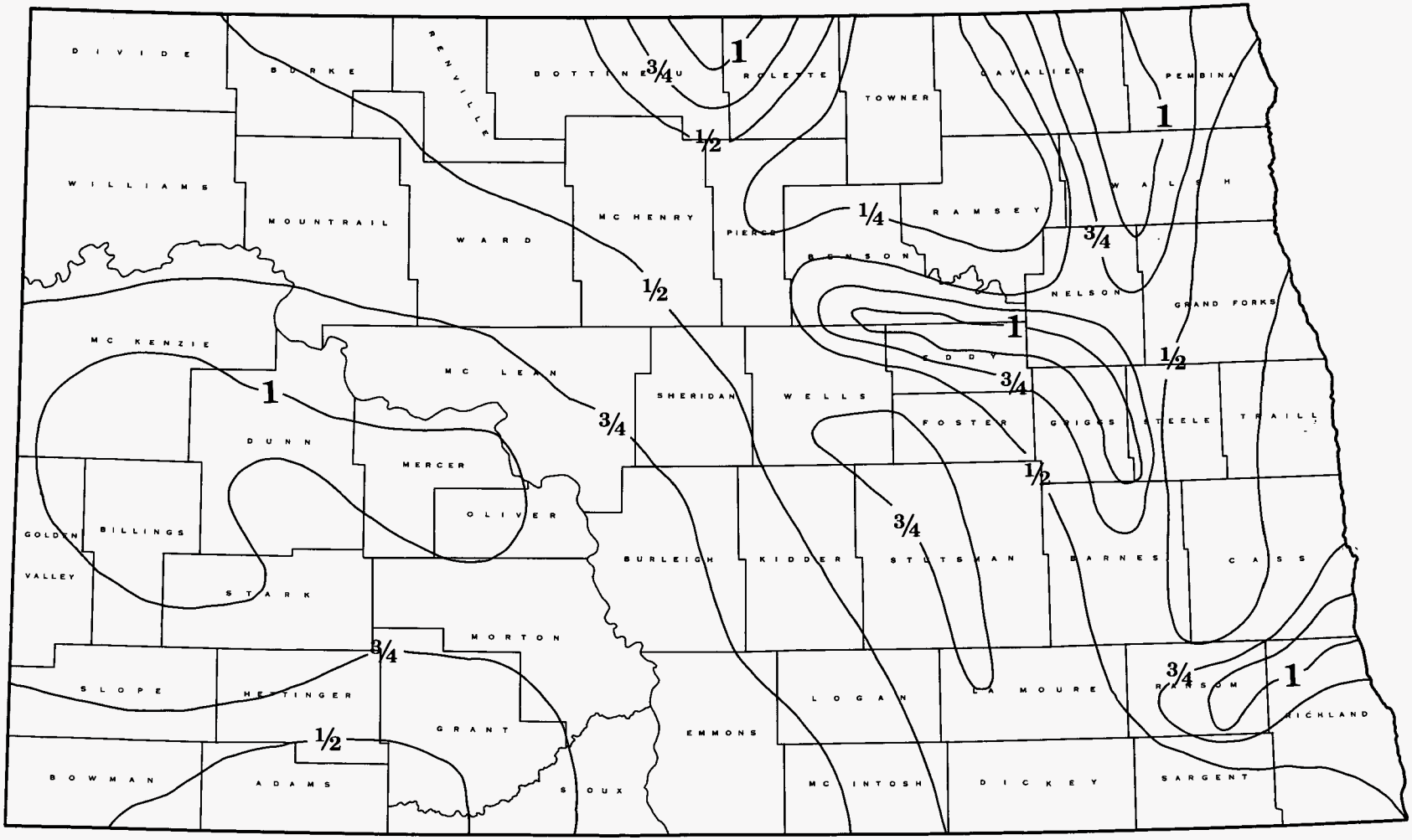
The unglaciated prairie has rolling topography with few steep slopes. Cover is provided by grasses, with some taller shrubs and trees in draws and windbreaks. Stream channels have stable to unstable banks and are usually well defined. Flooding can occur during the spring due to snowmelt, ice jams, and rain. Concentrations of dissolved solids are high, consisting of sodium sulfates and bicarbonates.

Surface hydrology characteristics for the semiglaciated prairie are nearly identical with those of the unglaciated prairie, because glaciation did not significantly alter the topography. However, as the glacial ice melted, channels were formed that were subsequently buried by later glaciers. These shallow, buried glacial valleys can be connected to surface channels and some shallow aquifer zones, forming a water bearing network.

The prairie pothole area was formed when stagnated glacial ice melted unevenly, leaving a hilly terrain where water filled the low spots. This area forms the drainage divide between the Missouri River and the Hudson Bay, but it does not contribute much surface runoff to either. The surface drainage is undeveloped, because of the small closed pothole, lake, or wetland basins found throughout the area. Water levels of these basins are determined by precipitation, basin area, evapotranspiration, and ground seepage. Depending upon the relative importance of these factors, water in potholes may have low or high concentrations of dissolved solids but rarely contain much sediment. Flooding can occur in or around these ponds during wet periods as water levels rise.

The glaciated prairie area was formed when glaciers sheared off the hilltops and filled in the valleys with till. Surface drainage is poorly developed and the area is dotted with numerous potholes, lakes, or wetlands. Stream channels are poorly developed, have flat gradients, slow velocities, and are prone to flooding from snowmelt. Streamflow is slow in response to rain or snowmelt events. Flooding can occur over relatively large areas and is slow to subside. Sediment is rarely a problem in this area, but dissolved solids concentrations can be high.

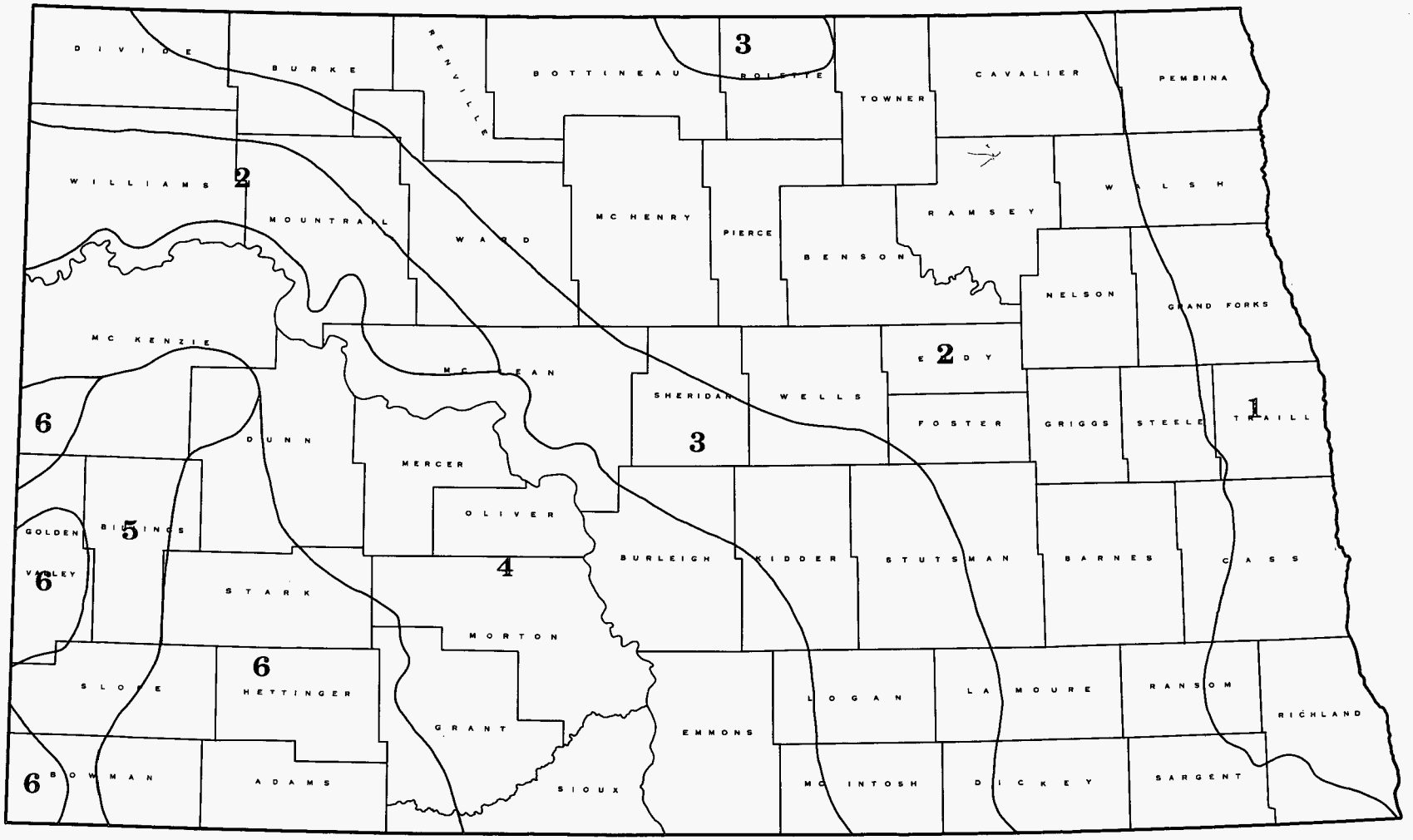




Average annual runoff in North Dakota in inches (Winter et al. 1984).

FIGURE 3-2

FIGURE 3-3



Surface hydrology characteristics (Mineral and Water Resources of North Dakota, Bulletin 63, North Dakota Geological Survey, 1973

LEGEND

1	Lake Agassiz Plain
2	Glaciated Prairie
3	Prairie Pothole
4	Semiglaciated Prairie
5	Badlands
6	Unglaciated Prairie

The Lake Agassiz Plain in northeastern North Dakota consists of lake deposits of ancient Lake Agassiz. This area is very flat. Streams are sluggish, meandering, and have well protected banks. Sediment loads and dissolved solids loads in streams are low, but nutrient levels are high.

Ground Water

Ground water is more evenly distributed throughout the state than surface water. Most wells finished in aquifers yield small quantities of water that generally are not large enough for commercial uses but adequate for domestic and livestock uses. Most rural and municipal water users in North Dakota depend on ground water for their domestic water source.

There are seven primary water-yielding zones (aquifers) located beneath the surface (Table 3-7). The areal extent of these is shown in Figure 3-4.

TABLE 3-7

PROPERTIES FOR THE MAJOR NORTH DAKOTA GROUND WATER ZONES

System/ ERA	Formation	Water Quality	Depth (feet)	Yield (gpm)
Quarternary	Alluvium & Buried Valley	Saline or Fresh	0-500	0-500
Tertiary	Fort Union	Saline or Fresh	0-1100	1-100
Cretaceous	Fox Hills-Hell Creek	Saline or Fresh	Few-2500	1-150
	Pierre	Saline	—	0-100
	Dakota	Saline	100-5600	0-500
Paleozoic		Saline	150-13,500	—
Precambrium		Fresh	300	Few

Source: Mineral and Water Resources of North Dakota. 1973. North Dakota Geological Survey. Bulletin 63. 252 pp.

Aquifers of the Fort Union Formation consist of silt and clay, interbedded with layers of sandstone and lignite. These sandstones and lignite beds are the water-yielding units. Movement in this system is slow and yields are around 10 gallons per minute (gpm). Dissolved solids concentrations are usually around 1000-2500 mg/l.

Generally, wells tapping aquifers in the Fox Hills-Hell Creek zone will usually yield fresh water wells yielding less than 30 gpm; but locally yields may be as high as 150 gpm. Total dissolved solid concentrations are usually 1000-3000 mg/l and locally can be as high as 10,000 mg/l.

The Pierre aquifer is not a major aquifer but may be the best source of water for farm and municipal use where a local fracture zone is unusually thick or large. Quality of water is extremely variable. Total dissolved solids will range from 700 to 12,500 mg/l.

The Dakota aquifer underlies most of North Dakota except for a narrow strip along the Red River. The aquifer is used for oil field purposes and salt water disposal in the western part of the state. In the eastern part of the state, it is a freshwater source for numerous farms and some municipalities. Quality of water is highly variable. Total dissolved solids concentration within the aquifer range from 3000 mg/l in eastern North Dakota to over 10,000 mg/l in western North Dakota.

The Paleozoic aquifer occurs throughout the state except where it is missing near the Precambrian aquifer. In the eastern part of the state the Paleozoic aquifer is used for domestic purposes. Water from the aquifer is used only for oil production purposes in the western part of the state. Total dissolved solids are 14,000 to 54,000 mg/l in the east and 58,000 to 330,000 mg/l in the west.

Precambrian rocks underlie all of North Dakota but are only considered to be an aquifer along the Red River where water may be obtained in fractures. Yields will not be more than a few gpm. Total dissolved solids will generally vary from 900-3000 mg/l.

Alluvium and buried-valley aquifers are some of the most important sources of high quality shallow ground water in the state (Figure 3-5). They are scattered throughout most of the glaciated portion of North Dakota and consist of sand and gravel deposits associated with perennial stream channels, buried preglacial channels, and buried glacial meltwater channels. Buried-valley aquifers generally yield 100-500 gpm, have relatively good quality water with total dissolved solids ranging from 400-2500 mg/l, and in most areas are considered suitable to marginal for irrigation purposes.

Surface Lands

The Big Gumbo area is located within the unglaciated Northern Great Plains physiographic province of the Missouri River Plateau. Water movement through the soil zone is primarily controlled by soil characteristics. Most of the area is made up of soils derived from shale parent material having slow infiltration rates of 0.0-0.05 inches/hour. Rain on snow, rain on saturated soils, or intense summer thunderstorms are the precipitation events that will typically produce runoff.

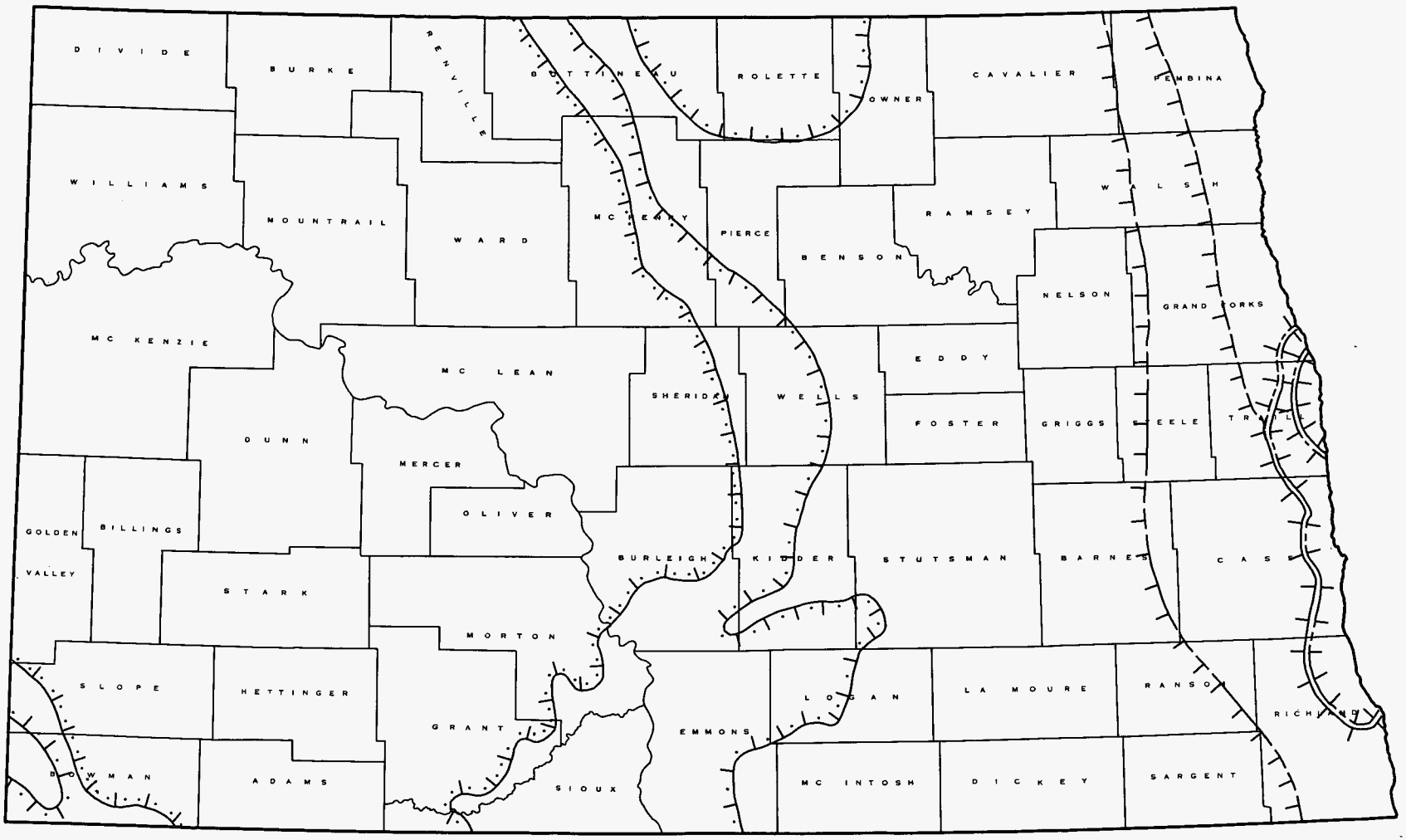
Surface drainage of the area is from west to east through ephemeral channels into the Little Missouri River. Surface water is available in small quantities. Small reservoirs between 5 and 12 acre-feet in size provide water for livestock and wildlife uses. Water quality is the major limiting factor for water use because of the high dissolved solids in the reservoirs and streams. Due to the relatively high sediment loads, reservoirs can be expected to last ten or twenty years before they silt in.

Surface waters are a sodium sulfate type with the following range of constituents: total dissolved solids (472-3840 mg/l), pH (5.5-9.8), sodium (59.5-886 mg/l), and sulfate (125-230 mg/l).

None of the freshwater aquifers that are important in the surrounding area are present in the Big Gumbo. Some of the sandy soils in the Big Gumbo area serve as recharge areas for the regionally important Fox Hills aquifer as this formation dips down and extends over much of eastern Montana, western North Dakota, and parts of northwestern South Dakota. The Little Missouri Scenic River runs along the eastern border of the public lands. Alluvium along this river contains ground water that is pumped for domestic use.

The Lost Bridge area is located in the unglaciated badlands along the Little Missouri Scenic River. Drainage areas are all less than 25 square miles and slopes are generally steep. The streams in the area are small and ephemeral, flowing as a result of snowmelt or intense rainstorms. A majority of the annual runoff occurs during the spring and early summer.

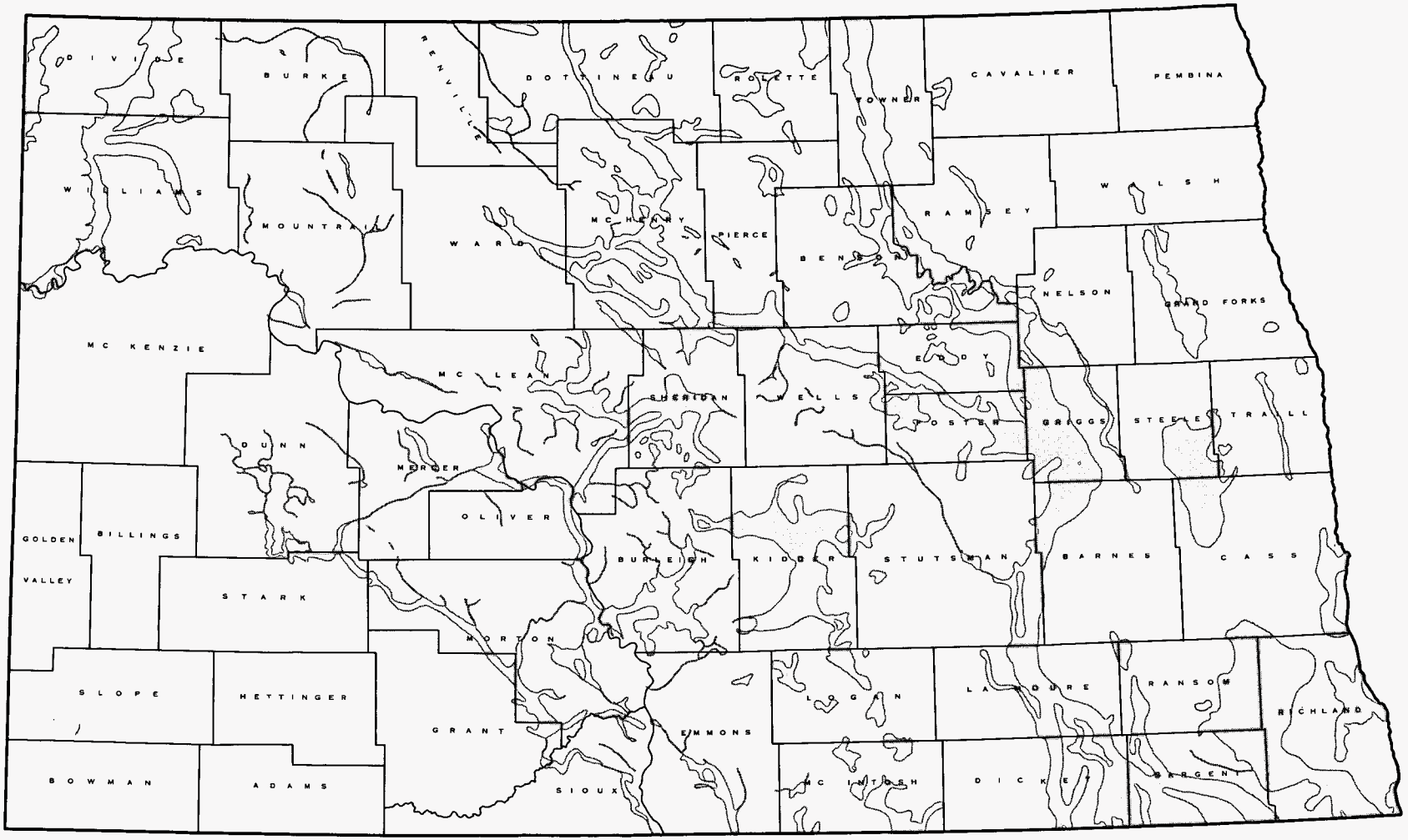
FIGURE 3-4



Major bedrock aquifers of North Dakota (Mineral and Water Resources of North Dakota, Bulletin 63, North Dakota Geological Survey, 1973).

LEGEND

- Fort Union Aquifer
- Pierre Aquifer
- Paleozoic Aquifer
- Common Boundary (Dakota and Paleozoic Aquifers)
- Fox Hills—Hell Creek Aquifer
- Dakota Aquifer
- Precambrian Aquifer



Location of major buried-valley aquifers in North Dakota (Winter et al. 1984).

FIGURE 3-5

Ground water in this part of North Dakota is closely related to the geology. There are several formations above 2000 feet that yield good quality water. The Sentinel Butte Formation extends from the surface to a depth of 700 feet. Water in this formation is found in lignites and sandstone. Because the formation is highly eroded, these zones are very localized and usually intersect the surface, forming springs. Recharge zones are also localized and occur in topographic highs.

Erosion

Wind and water erosion are problems that naturally occur on many soils in the Great Plains areas. Disturbed areas are more susceptible to erosion because of the decrease in vegetative cover and disturbance of the soils. Through cultivation, overuse by livestock, roads, and construction.

Vegetative ground cover is needed to protect soils from accelerated erosion caused by localized overgrazing, construction, and other surface disturbance. When plant cover is reduced by grazing or other factors, sheet, rill, gully, and wind erosion usually results. The most effective means to control wind and water erosion is by maintaining a suitable, diverse vegetative ground cover and by minimizing soil disturbance.

Sedimentation

High suspended sediment discharges are due to locally steep topography, shallow and highly erodible soils, and less resistant types of bedrock. Most of the annual suspended sediment discharge occurs during a few days of the year. Suspended sediment is carried in the streams during short periods of rapid runoff resulting from summer thunderstorms or snowmelt. Sediment concentrations during snowmelt runoff will generally be less than an equal volume of runoff generated by thunderstorms. Sediment concentrations and discharge typically increase as streamflow increases. The suspended sediment load of streams in the Big Gumbo and Lost Bridge areas is silt and clay; very little sand is transported in suspension.

VEGETATION

Coal Study Areas

North Dakota is situated on the eastern edge of the Northern Great Plains. Prior to settlement, the land was dominated by prairie grasslands with an interspersion of woody draws and shrublands. However, over the years much of the native vegetation in the planning area has been replaced with cultivated fields. Typically, the only prairies that remain are those topographically too rough or too saline to cultivate.

Agriculturally-disturbed land comprises about 70 percent of the vegetation types in the CSAs (Table 3-8). Another 25 percent is in native prairie, 3 percent is in shrublands, and 2 percent is in wooded draws. Each of the major native habitat types is described below.

Native Prairie

The remaining grasslands within the planning area occur primarily as mixed-grass prairie that is used for grazing of domestic livestock. The major grass species include needle-and-thread grass (scientific binomials in Appendix M), green needlegrass, western wheatgrass, thread-leaved sedge, and blue grama. The most common shrub species are western snowberry, western wild rose, and buffaloberry.

TABLE 3-8

PERCENT CROP AND RANGELAND WITHIN CSAs (ALL LANDS)

CSA	Percent Crop	Percent Range
Antelope	60	40
Arnegard	90	10
Beulah-Zap	50	50
Bowman-Gascoyne	80	20
Center-Stanton	60	40
Dickinson	80	20
Divide	90	10
Dunn Center	50	50
Elgin-New Leipzig	90	10
Elkhorn	50	50
Fortuna	70	30
Garrison	80	20
Golden Valley	95	5
New England	75	25
Niobe	90	10
Sand Creek	90	10
Tobacco Garden	40	60
Underwood	80	20
Velva	50	50
Washburn	80	20
Williston	50	50
Mott	65	35
Hanks	90	10
Keene	60	40
AVERAGE	70	30

The mixed-grass prairie habitat has a relatively consistent species composition throughout the planning area. There are, however, differences in structure which appear to be related to past land uses, especially grazing. Where grazing has been heavy, the taller grasses, like western wheatgrass and species of needlegrass tend to be less abundant and the lower growing species, like blue grama, tend to prevail. Topographic and soil differences also influence the character of the grasslands. For example, on sandy soils, prairie sandreed tends to dominate. On coarse, baked-clay substrates, western wheatgrass dominates.

Woodlands

Within the CSAs, woodlands occur primarily as deciduous wooded draws and to a lesser extent, shelterbelts, riparian, and juniper woodlands. The wooded draw habitat type develops in ravines where the microclimate, primarily greater moisture, is suitable for growth and development of trees. The major species include green ash, American elm, cottonwood, and quaking aspen.

Wooded draws also support a variety of shrub species including chokecherry, American plum, western snowberry, buffaloberry, red-osier dogwood, Missouri gooseberry, and Juneberry.

Common herbaceous species include the bedstraws, fringed loosestrife, spikenard, black snakeroot, and wild bergemot. Common grasses are Kentucky bluegrass, Virginia wildrye, long-beaked sedge, and little-seed ricegrass. Most of the wooded draws are grazed by cattle. As grazing increases young trees and shrubs are less abundant, and the understory becomes dominated by grasses.

The deciduous riparian woodlands occur along streams and rivers. Major species are the same as those in wooded draws but cottonwood is often dominant. The best developed stands of this type occur along the Missouri River.

Shelterbelts occur throughout the planning area and are usually associated with farm buildings and houses. Major species in the shelterbelts include Colorado blue spruce, ponderosa pine, cottonwood, American elm, green ash, box elder, Siberian elm, common lilac, and caragana.

The main juniper woodlands occur on the Williston CSA and are associated with the rough topography just north of Lake Sakakawea. The primary species is Rocky Mountain juniper. Understory species includes dwarf juniper, western snowberry, bedstraw, western wheatgrass, and long-beaked sedge.

Moist Shrublands

The moist shrublands within the study regions occur as two types: tall shrublands and low shrublands. The tall shrublands type is characterized by mixed stands of chokecherry, hawthorn, buffaloberry, silverberry, and Juneberry. Common herbaceous species include smooth brome and Kentucky bluegrass. The tall shrub type usually occurs along drainages and in sheltered shallow draws.

The low shrubland type also occurs along drainages, but requires less moisture than the tall shrubland type. The dominant species are western snowberry and western wild rose.

Wetlands

Among the remaining native habitat types, the most important are certainly the wetlands. Wetlands are prevalent only in the Velva, Divide, Fortuna, and Niobe CSAs. Vegetation on wetlands that only temporarily have water is similar to that of native prairie. A slight increase in moisture will support fowl bluegrass, prairie cordgrass, baltic rush, wild licorice, showy milkweed, and curly dock.

If standing water is present throughout the entire growing season, semi-aquatic species like slough sedge, Nuttall's alkaligrass, knotweed, sloughgrass, and prairie cordgrass, are dominant species.

On semipermanent lakes major species include common cattail, hardstem bulrush, softstem bulrush, chairmaker's rush, and common spikerush.

Alkaline lakes support fowl bluegrass, hardstem bulrush, softstem bulrush, and Nuttall's alkaligrass. The alkaline lakes are characterized by salt encrustations on the drawdown zone of the wetland.

Badlands

Vegetation in the badlands includes rubber rabbitbrush, longleaf sagebrush, black greasewood, big sagebrush, and silver sagebrush. Common grasses include bottlebrush squirreltail, western wheatgrass, and thickspike wheatgrass.

Dry Shrublands

Dry shrublands usually occur in association with badlands vegetation; forming a mosaic of shrubland types. Within the study regions, dry shrublands occur on the northern part of the Hanks CSA, on the northeastern and extreme western part of the Dickinson CSA, and on the northern portion of the Bowman CSA. The major shrub species are silver sagebrush, big sagebrush, rubber rabbitbrush, and black greasewood. The most common half shrub is broom snakeweed. Common grasses include various species of wheatgrass.

Threatened and Endangered Plant Species

At this time, there are no federally listed threatened or endangered plant species in North Dakota (Smith 1985). However there are two species listed as "Category 2" which means that there is insufficient information at present to judge their status. These are: yellow cress and prairie fringed orchid. The former species has yet to be found in North Dakota, and the latter, is locally abundant in the southeastern part of the state.

Surface Lands

Scattered tracts of BLM surface lands have all of the habitat types discussed above. Big Gumbo is dominated by native prairie with small areas of dry shrublands and badlands. In the Lost Bridge area there is native prairie, badlands, deciduous riparian, and wooded draw types. Wetland habitats occur on a number of small tracts north and east of the Missouri River.

Ecological range condition-expressed as excellent, good, fair or unclassified-reflects the current vegetation composition of the rangeland in relation to the potential climax plant community. Range condition for BLM grazing lands is 85 percent in good-excellent, 7 percent in fair, and 8 percent in unclassified condition (see Table 3-1 in USDI 1984a). The trend is upward on the three AMP allotments, but trend information on the rest of the allotments is limited. Trend is stable or better on isolated tracts.

Over 60 percent of the BLM rangeland is intermingled with private rangeland. The SCS periodically rates range condition for private rangeland on a statewide basis. They currently report over 60 percent of the private rangeland in good to excellent condition and 39 percent in fair and poor. Long-term trend is upward (Gerbig 1983, Runner 1983, USDA, SCS 1980).

Allotments listed as unclassified have limited or no inventory data. Most of these tracts are located along the Missouri River, beneath Lakes Sakakawea and Oahe, and in the central pothole region of the state. There are about 10,000 acres of wetland and submerged acres and about 3,000 acres of other land suitable for grazing.

Leafy spurge is the primary noxious weed known to exist on BLM lands in the District. It is found on several tracts in McHenry County, on one tract in Williams County, and on one tract in Cavalier County. The BLM District Office recently started a leafy spurge control in cooperation with grazing lessees.

WILDLIFE

Although BLM is committed to managing habitat for the benefit of all wildlife species, certain laws, regulations, and policies tend to focus attention on the habitats of important groups. The wildlife discussions in this document will focus on: federally-listed threatened and endangered species, potential state-listed threatened and endangered species, migratory bird species of high federal interest, and species of high interest to the State of North Dakota. Most species in these groups are equally likely to be encountered in CSAs, on surface lands, or on other mineral estate.

Species lists and scientific names are presented in Appendix M.

Federally Listed Threatened and Endangered Species

Bald Eagle

Bald eagle nesting has not been recorded in North Dakota for several years. Most of the wintering bald eagles occur along the Missouri River below Garrison Dam. Numbers have varied between 26 and 54 with the count largely dependent on the amount of open water available. Public land in this area is limited to a few small tracts largely within the Missouri River channel.

Peregrine Falcon

The peregrine falcon is present only during migrations. Although they nested in North Dakota in limited numbers historically, there are no known active nest sites. Sightings are erratic with no recognized trend.

Whooping Crane

Whooping cranes use numerous roosting and feeding sites in the western two-thirds of North Dakota during migrations. Any shallow wetland, stock pond, or stream with good lateral visibility may serve as a roost site. Past sightings have been widely scattered and unpredictable.

Interior Least Tern

North Dakota may be the northernmost nesting area for this species. Breeding colonies occur between Garrison Dam and Oahe Reservoir on the Missouri River. Small tracts of public land within the Missouri River channel may provide breeding sites.

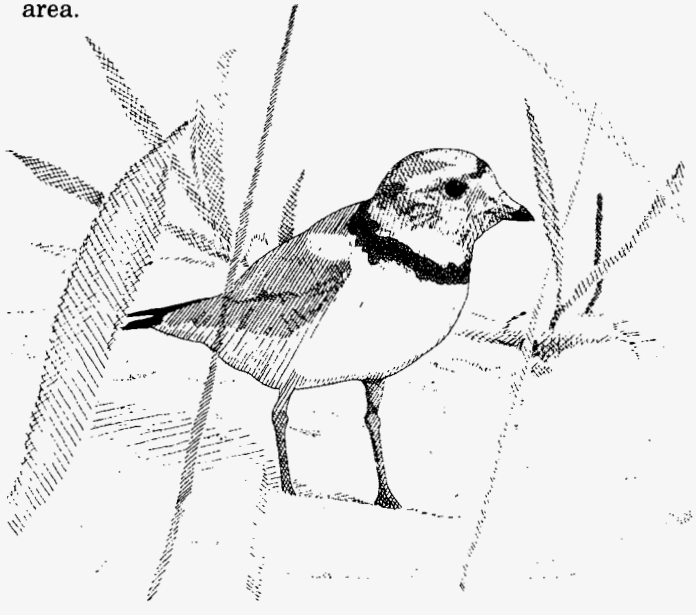
Black-footed Ferret

The last confirmed physical evidence of this species in North Dakota was a ferret killed in 1951 in Hettinger County. A skull of unknown age was found in 1980 in Billings County. Probable and unconfirmed sightings are periodically received from the southwestern part of the state.

Piping Plover

This species breeds on undisturbed beaches, alkaline lake shores, and sandbars and has been confirmed in Divide, Burke, Williams, Mountrail, Ward, McLean, Sheridan, Mercer, Oliver, Morton, Burleigh, and Renville Counties.

There is currently no formally designated critical habitat for threatened and endangered species in the planning area.



State Listed Threatened and Endangered Species

There are currently no species listed by North Dakota state law as threatened or endangered. However, a list of potential species (Appendix M) has been prepared (McKenna et al. 1982).

Migratory Bird Species of High Federal Interest

Most of these species (Appendix M) breed within the planning area, but their abundances vary. For some species, (e.g., ferruginous hawk, prairie falcon, and burrowing owl) specific nest sites are known and can be protected. Others are not dependent upon habitats likely to be affected by this plan, (e.g., white pelican, double-crested cormorant, greater sandhill crane, osprey). The remaining species either are uncommon or local, and site-specific population information is limited.

Species of High Interest to the State of North Dakota

Over 120 species are listed by the NDGFD as being of high interest to the state (Appendix M). Whereas it is not possible to give an account of each species, some general statements can be made about species groups and important individual species not addressed above.

Fishes

BLM has almost no affect on, or control over, deep water habitats of lake fish. Control of soil erosion and water pollution lies mainly in the private sector. BLM does manage a number of small parcels that contain parts of potholes and small lakes that may contain fish populations.

There are fewer than eight miles of perennial streams and rivers adjacent to public lands. Most occurs in stretches of less than one-fourth mile. Although these habitats can be managed along with their riparian habitats to aid quality fisheries, the overall effect in any given area is not significant in comparison to other uses along the waterways.

Waterfowl

Waterfowl habitat occurs primarily in the Velva, Divide, Fortuna, and Niobe CSAs, and, to a limited extent, on public lands in Bowman County. As mentioned above, numerous small parcels of public land also contain potholes. BLM is currently carrying out habitat improvement projects, alone and with Ducks Unlimited, to increase waterfowl nesting habitat. Waterfowl populations in North America have recently reached an all-time low due largely to drainage of wetlands and occurrences of drought in the prairie ecosystem.

Upland Game Birds

Sharp-tailed grouse occur widely in the planning area where there is a mixture of native prairie, shrublands, and agricultural lands. Production of young grouse in the planning area has been stable between 1977 and 1984 (Kobriger 1983, 1984, a, pers. commun.).

Ring-necked pheasants and gray partridge are common where there is cover adjacent to agricultural lands. These are two of only a few species that increase with the conversion of native habitats to agricultural lands.

Big Game

White-tailed and mule deer populations in North Dakota are managed by the NDGFD in permanent deer management units. About 9.9 percent of the units in the planning area are in CSAs, and about 0.2 percent are on BLM surface lands.

Projected white-tailed deer populations have generally increased in the planning area since 1953. This is especially true in the southwest portion of the planning area and along the Missouri River (McKenzie and Samuelson 1982). The most recent complete population inventory (1981-1982) gives average white-tailed deer densities of about 0.7 deer per square mile in the planning area.

Mule deer populations have been monitored in selected study areas in western habitats. These data reveal populations that have increased to 1982 and have possibly reached a stable point at about 6.5 deer per square mile (McKenzie and Samuelson 1982).

Pronghorn are managed in units different from those for white-tailed and mule deer. A total of 17.4 percent of all management units in the planning occur in CSAs and about 0.4 percent occurs on public lands.

Pronghorn densities as of 1984 are highest in the extreme southwestern corner of the planning area at 2.3 per square mile. Densities decrease to the north and east to much less than one per square mile (Samuelson 1985).

Pronghorn populations in the planning area reached a peak of over 14,000 in 1964 and decreased to an all time low of 1246 in 1979. Since then, numbers have recovered somewhat but are still lower than the long-term average. The trend has been downward in most units and stable in only a few. Only in one unit in Bowman County have numbers shown a long-term increase (Samuelson 1985). The steady loss of native grasslands may be responsible for this trend.

Raptors

Several inventories of nest sites of golden eagles, prairie falcons, and ferruginous hawks have been conducted in the area over the years (Grier et al. 1978, Gaines 1980, 1981a, b, Bosch 1981, Ward et al. 1985, Harrington 1984). Currently, only a few potential nesting areas have not been inventoried. Nesting populations are calculated to be 95 + 79 pairs of golden eagles and 125 + 94 pairs of prairie falcons in the planning area (Allen 1985). No estimate of the nesting ferruginous hawk population is available.

Only limited data are available for other raptor species listed in Appendix M. Several nest sites of Swainson's hawks have been located. Although this species is currently under consideration for listing as Threatened or Endangered, it is common in the area. Because of its abundance, its adaptability to various types of nest sites, and the abundance of suitable sites, no systematic inventory or monitoring effort has thus far been carried out.

Several nest sites of burrowing owls have been located during inventories of this species and incidental to inventories of black-tailed prairie dog towns. Nationally, populations of this species have been declining but no population or trend data are available for the planning area.

Population densities and trends of other raptors in Appendix M are unknown.

Black-Tailed Prairie Dogs

Over 600 known and potential (interpreted from aerial photographs) prairie dog towns have been located in North Dakota. Information on these towns from a variety of sources has been compiled by USFWS because of the relationship between dog towns and black-footed ferrets. Currently, only five towns occur in CSAs and only two on public lands.

Other Nongame Species

Populations of the other species listed in Appendix M are known only generally (Stewart 1975, McKenna et al. 1982, McKenna and Seabloom 1979, Armbruster 1983).

Surface Lands

Most of the species discussed above could occur on scattered tracts of public lands. However, two noteworthy species, sage grouse and elk, occur primarily on public lands.

Sage grouse populations are small and found in the limited area of sagebrush habitat in the southwestern part of the planning area. BLM has its largest contiguous block of surface lands in sage grouse habitat. Sage grouse habitat is marginal due to a lack of good sagebrush for nesting and winter cover and a lack of good brood-rearing habitat. Populations have fluctuated widely since 1964 when studies were begun. The long-term population trend has been stable to slightly downward (Kobriger 1983, 1984, b, pers. commun.).

The elk population near Lost Bridge on the Little Missouri River reached 91 individuals in April 1985. This population is increasing and is hunted.

The Bighorn sheep population in the badlands has increased steadily since 1972. In the fall of 1983 and 1984, 135 sheep were counted (Samuelson 1985a). This population currently may use some of BLM's scattered surface lands in McKenzie, Dunn, and Golden Valley counties. Because much of this habitat is suitable for bighorns, we expect the population to expand more into these areas over future years.

AGRICULTURE

In the 24 counties located in the western half of North Dakota, cropland acreage is approximately equal to that of range and pasture land. The ratio varies from county to county. For example Renville County has almost 80 percent cropland whereas Billings County has only 15 percent cropland. The region is most noted for its production of spring and durum wheat. Oats, barley, and sunflowers are some of the other important crops grown.

Fifty percent 1,000,000 of North Dakota's cattle are found in this region. Dairy cattle make up 10 percent of this number.

Coal Study Areas

Ninety-five percent of the CSAs is used either for livestock grazing or crop production. Most of the land (70 percent) is

used for crop and hay production (Table 3-8). The remaining 30 percent is range land used for grazing.

A typical farm operation has its main emphasis on growing cash crops and uses livestock for supplemental income. Major crops include small grain, row crops and hay. Wheat is the principal cash crop grown. Most of the barley, oats, and corn grown remains on the farm and is fed to livestock. Sunflowers are also grown in each of the CSAs as a cash crop. In the planning area McLean and Hettinger Counties have the two largest acreages of sunflowers. About one-fourth to one-third of the cropland acreage is summer fallowed each year.

There is not a significant amount of acreage under irrigation. However, eight of the CSAs contain lands having irrigation permits in various stages of development. None of the areas are part of large-scale irrigation development.

Livestock production includes beef cattle, hogs and dairy. Beef herds average about forty head per farm and graze both the untilled portions of the operation in the summer and crop aftermath in the fall. Hay feeding is necessary through the winter and spring. Calves are usually sold in the fall and winter. Most dairies are Grade B and produce milk used in making cheese.

Surface Lands

The Dickinson District leases 53,420 acres (9751 animal unit months (AUMs)) for grazing to 94 individual operators. Each lease is referred to as an allotment. The district has 97 allotments, ranging in size from 15 acres up to 8,925 acres.

In 1968 and 1969, AMPs were developed on three allotments in western Bowman County, which contain the only block of BLM land in the state lending itself to intensive range management. The rest is managed on a custodial basis. At the time of implementation the stocking level on one of these allotments was reduced by one-third and grazing systems were established on all three. Significant improvement in range condition has resulted, although the vigor and canopy coverage of shrubs probably is still below potential. Some of the pastures are still deficient in stock water development.

The three AMP allotments are the only ranch units using BLM lands with a high percentage (over 60 percent) of federal range. The percentage of federal range on the other units varies between 1 percent and 25 percent and averages 5 percent.

Most operators run a cow-calf operation, with an average herd size of 200 head. There are four operators that run both sheep and cows, and four that run yearlings. Generally, the season of use is May through November. Supplemental feeding usually is required for the rest of the year. Most ranches have some cash crops included in their operation. The ranches are typically family-owned and operated.

LANDS

Coal Study Areas

There are 25 scattered parcels of public lands totalling 1318.57 acres in the CSAs. These are:

CSA	*Public Surface Lands*	*Alternative*
Arnegard	T.149N., R.102W., Section 17, NE¼SE¼	A, B, C, D
Beulah-Zap	T.143N., R.89W., Section 34, NW¼SW¼	B, C, D
Keene	T.149N., R.95W., Section 1, Lot 1	A, B, C, D
	T.150N., R.95W., Section 24, Lot 4	A
	Section 25, Lot 1	A
Sand Creek	T.156N., R.102W., Section 14, NE¼SW¼, NW¼SE¼	A, B, C, D
	T.153N., R.104W., Section 10, Lot 1	A, B, C, D
Tobacco Garden	T.151N., R.99W., Section 6, Lot 5	B, C, D
	T.152N., R.98W., Section 5, Lots 10, 11, 12	A, B, C, D
	T.153N., R.98W., Section 24, SW¼SE¼,	A, B, C, D
	Section 25, W½NE¼	A, B, C, D
	T.152N., R.99W., Section 7, Lot 3	B, C, D
	Section 24, NW¼NE¼	B, C, D
	T.152N., R.100W., Section 24, SE¼NW¼, SW¼SW¼, SE¼SE¼	B, C, D
	Section 25, W½NW¼	B, C, D
Williston	T.154N., R.95W., Section 7, Lots 2, 3, 4	A, B, C, D
	Section 10, N½SE¼	A, B, C, D
	T.155N., R.95W., Section 12, SE¼NE¼, NE¼SE¼	A, B, C, D
	T.154N., R.96W., Section 12, SE¼NE¼, NE¼SE¼	A, B, C, D
	T.154N., R.97W., Section 17, SW¼NE¼	A, B, C, D
	Section 21, SE¼SE¼	A, B, C, D

Surface Lands

There are 67,520 acres of public surface estate administered by the BLM in 32 North Dakota counties (Table 3-9). Most of the land surface administered by the BLM is concentrated in western Bowman County and northwest Dunn County.

Throughout the district, approximately 2,800 acres of public lands have been patented via the Recreation or Public Purposes Act since 1957. The last R&PP patent was issued in 1983. The lack of available public lands near population centers will restrict R&PP applications in the future.

During recent years a number of cases of unauthorized land use have been identified. These are expected to continue to increase slightly during the next five years due to economic conditions. Most of the present unauthorized use has been occurring for a number of years. The most frequent types of unauthorized use are agricultural, roads and pipelines. Unauthorized use appears to be more prevalent with isolated, scattered tracts. These tracts often create difficulty in boundary recognition by the public and in trespass abatement efforts by BLM personnel.

In 1983, approximately 3,550 acres of public lands were identified for possible inclusion in the Garrison Diversion Unit Wildlife Mitigation Plan. Evaluation of data has removed all the lands from further consideration for mitigation except for the following:

Logan County
T.136N., R.68W.
Section 30, NW¼NE¼

McHenry County
T.152N., R.77W.
Section 23, SW¼NE¼

Mountrail County
T.156N., R.88W.
Section 17, SW¼NE¼
T.158N., R.90W.
Section 18, SE¼NE¼

TABLE 3-9
NORTH DAKOTA BLM-ADMINISTERED LANDS AND MINERALS[1]

County	Total Mineral Acres[2]	Coal Acres	Oil & Gas Acres	Surface and all Mineral Ownership Acres
Adams	109,262	108,062	5,715	40
Barnes	7,415	7,415	7,415	5
Benson	4,371	4,211	4,251	89
Billings	53,806	51,103	4,646	680
Bottineau	6,327	6,327	6,127	1
Bowman	246,441	231,447	61,243	32,568
Burke	81,664	80,626	5,709	
Burleigh	40,397	13,174	863	40,957
Cass	480	320	320	
Cavalier	9,724	9,284	9,284	239
Dickey	1,957	1,437	1,437	
Divide	275,312	275,312	9,521	1,666
Dunn	433,407	428,703	47,823	15,989
Eddy	3,364	3,364	3,404	54
Emmons	13,469	13,368	13,469	599
Foster	4,833	4,513	4,513	
Golden Valley	181,045	180,099	10,418	2,358
Grand Forks	520	520	520	40
Grant	99,625	97,970	14,059	584
Griggs	2,915	2,915	2,915	
Hettinger	241,915	238,137	8,152	
Kidder	11,937	11,937	11,937	1,520
LaMoure	10,778	9,498	9,498	
Logan	8,505	8,465	8,505	523
McHenry	21,209	20,238	17,568	3,233
McIntosh	4,656	4,656	4,656	213
McKenzie	567,353	561,092	16,044	1,629
McLean	129,988	128,596	14,315	599
Mercer	167,869	165,949	4,410	459
Morton	64,273	64,273	458	199
Mountrail	306,438	302,436	17,154	997
Nelson	2,083	2,083	2,083	
Oliver	95,588	94,191	4,110	112
Pembina	2,341	2,341	2,341	
Pierce	4,143	4,043	4,143	166
Ramsey	10,457	10,297	10,297	
Ransom	720	720	720	
Renville	16,579	16,419	6,536	78
Richland	2,199	2,199	2,199	
Rolette	3,141	3,061	3,141	
Sargent	2,724	1,444	2,084	
Sheridan	55,265	54,425	12,544	378
Slope	100,411	99,771	1,894	
Stark	167,560	167,360	2,619	
Steele	1,398	998	998	
Stutsman	18,468	17,948	18,148	80
Towner	6,115	5,315	5,315	
Trail	880	880	880	
Walsh	1,669	1,669	1,669	11
Ward	113,121	113,121	8,063	266
Wells	13,064	13,064	13,064	
Williams	497,406	492,624	18,886	1,321
TOTALS	4,226,984	4,166,640	460,394	67,520

[1]Does not include federal minerals located under USFS, USFWS, Army Corps of Engineers and other federal surface management agencies.
[2]Includes total, fractional or segregated interest.

Approximately 330,800 acres of public lands, excluding USFS administered lands, have been withdrawn since 1903 (Appendix J). A withdrawal is a formal action withholding an area of federal land from settlement, sale, location, or entry under some or all of the general land laws. The purpose is for limiting activities in order to maintain other public values, reserving an area for a particular public purpose, or transferring jurisdiction of an area from the BLM to another federal agency.

Approximately 8,000 acres were classified under the C & MU Act of 1964 (Appendix J). Classifications under the C & MU Act identified many areas of public land as suitable for retention in public ownership and closed substantial portions to various forms of disposition. These classifications were essentially obviated when Congress passed FLPMA. Other areas were designated suitable for a specific type of disposal; e.g., R & PP Act. All C & MU classifications in the District were terminated in 1982 and 1983. Removal of the classifications was an administrative action and has caused no adverse impacts.

On July 15, 1985, the NWF filed suit in the U.S. District Court for the District of Columbia alleging BLM's withdrawal review activities: (1) failed to analyze revocations in land use plans and EISs, (2) are being conducted without regulations, (3) fail to provide for public participation in decisionmaking, and (4) fail to provide for Congressional and Presidential review of proposed revocations. The NWF requested a preliminary injunction to prevent actions affecting withdrawal classification or designation in effect on January 1, 1981, and to execute an emergency reinstatement of withdrawals, classifications (including the C & MU classifications), or other designations in effect on January 1, 1981. The case resulted in Civil Action No. 85-2238 by which U.S. District Judge Pratt enjoined the BLM from modifying, revoking or terminating, under authority of FLPMA, any existing withdrawals or classifications in effect January 1, 1981. The Order precluded all action prohibited by the specific provisions of the withdrawals or classifications.

Two withdrawals are affected by the Order. One is withdrawal case M-8099 (ND), EO No. 8124 establishing Lake Oliver Migratory Wildlife Refuge. Federal interest in the land was through a revokable easement. The action had no effect on surface or mineral estates, which have been and remain in private ownership. The revocation was in effect February 5, 1982. The other is case M-10815 (ND), EO No. 7799 covering the Lower Souris National Wildlife Refuge, was partially revoked to remove a cloud on the surface title of the lands. The revocation was effective March 18, 1982.

Access to public land is not an issue in the District. In North Dakota the courts have affirmed section lines provide legal access irrespective of the presence of a road or trail. Most tracts of public land have legal access although in many cases there is no road or trail. In some cases legal access is arduous and lengthy.

There are no officially designated corridors in the District. There are numerous rights-of-way in the District; some utilize the same corridor.

The NDPSC has siting authority for energy conversion and transmission facilities powerlines larger than 115 KV and transportation pipelines as defined in the North Dakota Siting Act. It has designated exclusion and avoidance areas for these facilities. Exclusion areas are removed from consideration while avoidance areas are utilized only if there are no reasonable alternatives. No public lands are within exclusion areas. All public lands are designated "Areas of Recreational Significance" by the NDPSC and are classified as avoidance areas.

Big Gumbo Area

The Big Gumbo area is located in the southwest portion of Bowman County, North Dakota, between the Little Missouri River and the Montana state line. It is the largest solidly blocked area of public lands administered by the BLM in North Dakota and consists of 22,164 acres.

Lost Bridge Area

The Lost Bridge area encompasses all the public lands in Dunn County, North Dakota. The largest concentration is in the two and one-half townships located between the Fort Berthold Indian Reservation and McKenzie County. There are 15,989 acres of public lands in the area.

Scattered Tracts

Outside the Big Gumbo and Lost Bridge areas, there are 29,367 acres of surface estate administered by the BLM in North Dakota. The largest surface acreages are located in Bowman, Divide, Kidder, McHenry, McKenzie, Mountrail, and Williams Counties. Most of the tracts are widely dispersed and vary from 0.05 to 320 acres in size.

RECREATION

Coal Study Areas

The following discussion describes recreational opportunities in the general area surrounding the CSAs and surface lands.

Major outdoor recreation activities include fishing, boating, hunting, and sightseeing. Of these activities, hunting and sightseeing would be most common on BLM-administered lands. Recreational activities taking place on private lands or pubic areas other than BLM lands may also be affected by BLM management actions and are briefly described here.

The Missouri River and its impoundments Lake Oahe and Lake Sakakawea are the focal points of many water-based recreational activities in western North Dakota. Campgrounds, picnic, and boating facilities are in close proximity to the lakes and river.

Fishing is one of the most popular water-based recreational activities in North Dakota and is especially popular on the Missouri River system. Fishing also occur on the Knife, Cannonball, Heart, and the Little Missouri Rivers, but these rivers are not as popular as Lake Sakakawea. Public lands presently provide very limited opportunities for sport fishing — primarily along the Little Missouri River in the Lost Bridge area.

Hunting is a popular recreational activity in North Dakota. Upland game birds that are most frequently hunted are sharp-tailed grouse, gray partridge, and pheasant. These birds are hunted in many parts of the planning area. Waterfowl hunting is popular in the prairie pothole region, scattered waterfowl production areas, stockdams, farmponds, and open fields near larger bodies of water. Big game hunting, mule deer, white-tailed deer, pronghorn, elk, bighorn sheep, and moose is popular in North Dakota. Public lands are especially popular for pronghorn and mule deer hunting; providing a significant portion of all of the publicly-owned lands containing these species. There is also the potential for huntable populations of elk and bighorn on public lands in the Lost Bridge area.

Recreational opportunities on public lands are limited to dispersed activities, with hunting the most popular recreational use. There are no developed recreational facilities on the public lands.

The Big Gumbo and Lost Bridge areas offer the greatest recreational opportunities. The Big Gumbo area is popular for pronghorn and mule deer hunting as well as occasional upland bird hunting. The Big Gumbo area constitutes the major portion of publicly-owned lands containing huntable populations of sage grouse in North Dakota. The Lost Bridge area offers hunting for mule deer, turkey, and sharp-tailed grouse.

Under existing management ORV use is permitted throughout the year on all public lands. Most of the ORV use occurs within the Big Gumbo area where access to public land is easiest. Hunters, ranchers, and oil and gas personnel are the principal participants. Four-wheel drive organizations have indicated interest in the Big Gumbo area, but due to its isolation from larger population centers little ORV use has developed.

The draft Statewide Comprehensive Outdoor Recreation Plan (SCORP; NDPRD 1980) identified a number of goals which federal agencies should continue or work toward. One of these goals addresses management of river systems located adjacent to federally administered land. The BLM manages public land near the Little Missouri State Scenic River and the Missouri River. These areas were identified as having potential for recreation; however, most of these parcels are small isolated tracts of less than 200 acres.

Recreation opportunities exist throughout the planning area on lands administered by other federal or state agencies including USFWS, National Park Service (NPS), USFS, and Army Corps of Engineers. Many National Wildlife Refuges, waterfowl production areas, and easements administered by the USFWS lie within the planning area. Recreational opportunities include auto tours and observation of wildlife, photography, sightseeing, hunting, and fishing.

The NPS administers Theodore Roosevelt National Park. Major attractions to this area are sightseeing, camping, canoeing, horseback riding, and picnicking. The park is situated in the badlands and offers unique opportunities for nature study and sightseeing.

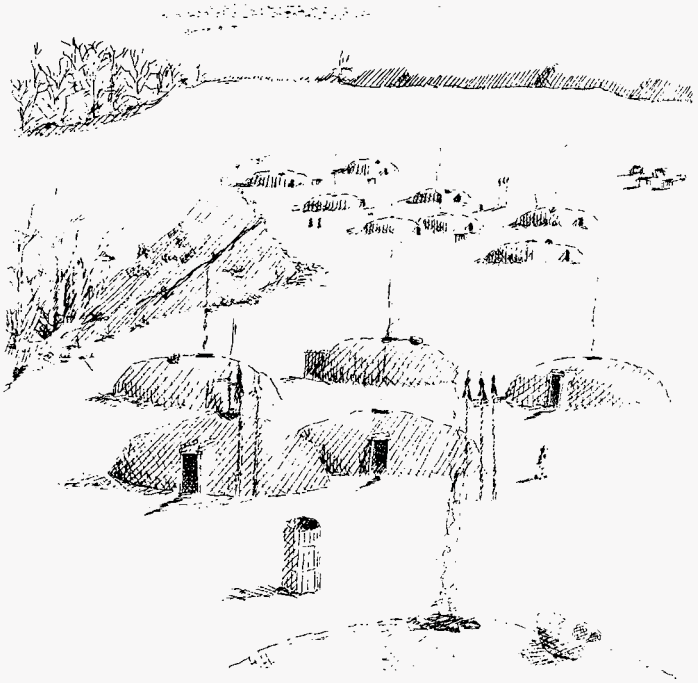
The Little Missouri National Grasslands administered by the USFS contains about one MM acres. Hunting is the major recreational activity in this area. Nature study, sightseeing, hiking and horseback riding are also popular. The Grasslands constitute the largest area of publicly-owned land in the state.

CULTURAL RESOURCE MANAGEMENT

Federal agencies, in response to the National Historic Preservation Act, must identify or cause to be identified National Register or eligible properties within the area of a federal undertaking. Because of those laws and regulations, the BLM has required cultural resource surveys and investigations, to identify sites which are most important to our understanding of the prehistory and history of North Dakota. These include sites which can be dated, contain artifact diversity and have contextual integrity. Additionally, sites which contain earthen mounds, ceramics, charcoal for dating, standing structures and stone ring sites with buried rings, are also significant (Gregg 1985).

The sites described below represent examples of the significant sites in North Dakota. Inventory results suggest that sites similar to those described are situated on surface lands within the CSAs. Detailed descriptions of the cultural resources will not be available until intensive invento-

ries are completed either for the purpose of BLM activity planning or in response to a specific project proposal. The following site descriptions are provided as examples of cultural resources which are likely to be encountered during future actions and form the basis of the projections of impacts presented later in this document.



Knife River Flint Primary Source Area

The primary source area of Knife River Flint (KRF) contains the largest known flint quarrying activities in North America (Loendorf, Ahler, and Davidson 1984). The area has been roughly defined through aerial photography of quarry sites located in Dunn and Mercer Counties (Clayton et al. 1970). The primary source area for KRF extends 43.5 miles east-west and 25 miles north-south, primarily along portions of the Knife and Heart Rivers. There are other locations in North Dakota where KRF has been identified, but archaeological evidence indicates the most intensive prehistoric quarrying activities occurred within the primary source area.

Quarry sites typically consist of depressions, 10 feet to 66 feet in diameter and range in depth from a few inches to more than 10 feet. The stone extracted from KRF quarry sites is a honey- to brown-colored translucent stone which aboriginal populations used to produce stone tools. Stone tools manufactured from KRF have been found as far north as southern Alberta and Ontario extending south to Colorado and Ohio. The earliest known use of the quarry dates to 12,000 years ago and continued to the historic period. Because of the magnitude of the quarrying activity, its antiquity, and its widespread distribution via trade or transport, the archaeological community strongly supports the assessment that this resource is significant at a national level.

Twenty-nine quarry sites are reported for the primary source area of KRF. Sixteen of the 29 lie within an eligible National Register District or about 5 percent of the primary source area. Half of the 16 are associated with the Lynch quarry, the type site. Also within the boundaries of the district are 31 workshop areas, 5 camp sites, 1 tipi ring, and 1 rock cairn. These sites have the potential to yield significant information on the prehistory of North Dakota. Specifically, they can answer questions dealing with quarry procurement strategies, lithic reduction techniques, and the role of KRF in trade networks throughout prehistory.

It is estimated the Dunn Center CSA contains 1300 aboriginal KRF sites. Many of these sites, which are part of the KRF primary source area, are quarries or are quarry-related.

The data recovered from excavations of KRF quarry or related sites has begun to reveal significant information on flintnapping and quarrying techniques of aboriginal groups through time. Future investigations are expected to address the range of functional activities conducted at the quarries and related sites and how those activities were integrated into the settlement systems (e.g., subsistence activities) and social structures of aboriginal groups within and outside of the primary source area of KRF. In addition, this data could reveal how KRF was distributed and the nature of the distribution links facilitating trade and transport of KRF to distant areas.

Moe Site (32MN101)

The Moe site is situated on the banks of Lake Sakakawea near New Town, North Dakota. The site is described as a series of occupations dating from Clovis to the Archaic (Schneider 1975). Radiocarbon dates and most of the material culture indicate the major occupation occurred during the Archaic period. Due to the high rate of erosion much of site had, prior to investigation, been destroyed. As a result, it is impossible to accurately reconstruct the sequence of occupations.

This site represents one of the few Paleo-Indian sites with primary context in North Dakota. Sites like these, in an undisturbed context, are possible in central and western North Dakota.

Writing Rock Historic Site

Writing Rock Historic site located just south of Alkabo in the Fortuna CSA represents one of the few examples of rock art in North Dakota. The site consists of boulders inscribed with abstract and zoomorphic designs. Evidence suggests that the designs were carved by aboriginal groups during the Late Prehistoric and Historic periods (Joyes 1978).

Systematic inventory of this area by professional archaeologists is limited; however, local amateur archaeologists have reported aboriginal artifacts and tipi rings from the immediate vicinity.

Mondrian Tree Site (32MZ58)

The Mondrian Tree Site is located near the Missouri River about four miles downstream from the confluence of the Missouri and Yellowstone Rivers. The site is composed of 8 stratigraphically discrete components dating from the Middle Archaic to Plains Village/Late Prehistoric period (Toom and Gregg 1983). Based on the material recovered, the site represents a temporary hunting/gathering camp where bison, elk, and deer were hunted and plant material was collected and processed.

Thirty radiocarbon dates were obtained from features located within the eight cultural zones. The dates ranged

from 2080 + 100 B.C. to A.D. 1850. The information gleaned from the Mondrian Tree site has provided a better understanding of prehistoric settlement in North Dakota. Further evaluations of site data will undoubtedly occur as more comparable information in the surrounding area accumulates.

Site 32SK29

Near White Butte in the Dickinson CSA are a distinctive set of wagon ruts possibly dating to 1874. Discovered in 1981 the ruts may be remnants of the Custer Expedition to the Black Hills in South Dakota. According to historic accounts that expedition passed through the general site area on its return to Fort Lincoln. The depth of the wagon ruts and the lack of parallel alternate ruts appear to indicate short-term intensive use by a large number of wagons (e.g., military supply wagon train) (Fox and Schweigert 1982).

Hutmacher Complex

The Hutmacher complex consists of two related farmsteads near Manning, North Dakota. The Valentine Hutmacher homestead was constructed in 1911 by immigrants from south Russia and consists of three buildings. Each of the buildings (now in ruins) was constructed employing architectural methods from south Russia and the Ukraine. The adjacent farmstead is comprised of six structures built between 1928 and 1930. These two farmsteads are the best known examples of stone-slab construction of eastern European origin.

The significance of the Hutmacher complex lies in the purity of the architectural techniques which have their origins in the traditional folk building mode. It is also significant because of the information it has provided on homesteading by eastern Europeans in North Dakota between 1911 and 1930.

PALEONTOLOGY

Fossil localities are not abundant in the planning area of western North Dakota. However, actual and potential fossil sites have been located (Bluemle 1977).

The Cretaceous Hell Creek Formation contains exposures that have produced a triceratops in Slope County and other dinosaur bone specimens in Bowman County. Dinosaur bones appear to be fairly common within this formation usually producing at least fossil fragments and occasionally a complete skeleton.

The Paleocene Ludlow Formation contains an abundant fossil assemblage, including fossil fish and turtles. Primate fossils and primitive horse fossils have been reported as well as crocodiles and champsosaurs.

Vertebrates found within the Golden Valley Formation in Slope County include fossil fish, frogs, reptiles, birds, rodents, carnivores, pantodonts, perrisodactyls, and artiodactyls.

Fossils from the Coleharbor Formation of the Pleistocene Epoch are fairly abundant. Extinct forms of Pleistocene fauna including mammoth and bison are reported for the planning area.

Two sites located within CSAs are especially important. One produced a new species of Paleocene Age *Pisidium* mollusks (Velva CSA), the other a new species of Oligocene-age frogs (Dickinson CSA). Type localities like these are rare and should be preserved for future scientific study.

Two areas in Stark County consisting of Oligocene White River sedimentary rocks contain abundant vertebrate fossils including rhinoceroses, rodents, rabbits, 3-toed horses, camels, saber-toothed cats, snakes, lizards, birds, and frogs. Mollusks and plants were also located at these sites. These sites are significant and quite rare and have provided and will continue to provide data on the climatic and environmental conditions 35 MM years ago in western North Dakota (Hoganson, pers. commun.).

ECONOMIC AND SOCIAL CONDITIONS

The following counties comprise the primary social and economic impact area: Adams, Billings, Bottineau, Bowman, Burke, Burleigh, Divide, Dunn, Grant, Golden Valley, Hettinger, McHenry, McKenzie, McLean, Mercer, Morton, Mountrail, Oliver, Renville, Sheridan, Slope, Stark, Ward, and Williams Counties. There are five communities in the impact area with 1980 populations greater than 3,000. These are Bismarck in Burleigh County with a population of 44,485, Minot in Ward County with a population of 32,843, Dickinson in Stark County with a population of 15,924, Mandan in Morton County with a population of 15,513, and Williston in Williams County with a population of 13,336. These communities serve as trade and service centers for western North Dakota. There are numerous communities in the impact area with 1980 populations less than 3,000 (USDC 1981).

The impact area is primarily rural in character although substantial coal and oil and gas development have occurred. Bowman, McLean, Mercer, and Oliver Counties each produced more than one MM tons of coal in Fiscal Year 1985 (FY85) (North Dakota Tax Department 1985). Billings, Bottineau, Bowman, Burke, Divide, Dunn, McKenzie, Renville, Stark, and Williams each produced more than a MM barrels of petroleum in 1984 (NDIC 1985).

Population Characteristics

The 1980 population of the impact area is 280,000; this represents 43 percent of the total population of North Dakota. The impact area population grew 9 percent during the years 1970 to 1980 compared to a growth rate of 6 percent for the state as a whole. The counties with the larger population centers and those experiencing energy development grew the most. Burleigh, Stark, Mercer, Morton, McKenzie, and Williams Counties all grew more than 15 percent. Many rural counties experienced population declines during this decade due to out-migration (USDC 1981).

Population estimates for 1985 indicate the area grew approximately 6 percent between 1980 and 1985. Again, growth occurred in the counties with larger urban areas while the population remained stable in many rural counties (NDSU 1982).

Population projections for the year 2000 predict an area growth rate of approximately 23 percent between 1980 and 2000. Counties with large urban centers (Burleigh, Morton, Stark, Ward, Williams) and energy development areas

(McLean, Mercer) are projected to grow while many rural counties are projected to decline in population (NDSU 1985).

Many of the counties in the impact area are sparsely settled; 16 of the 24 counties contained fewer than five people per square mile in 1980. However, in 1980, 50 percent of the area residents lived in urban areas (places of 2,500 or more inhabitants) while only 16 percent were classified as rural farm. By county in 1980, the percent of residents living in urban areas varied from zero in many of the more rural counties to nearly 83 percent in Burleigh County where Bismarck is located. The percent of rural farm population varied from a low of 3.7 percent in Burleigh County to 65 percent in Slope County. In Slope, Billings, Dunn, Sheridan, and Grant Counties more than 45 percent of the population is classified as rural farm (USDC 1983a, 1983b).

One Indian Reservation is located within the primary impact area and another is located adjacent to the impact area. Fort Berthold Reservation is located in Dunn, McKenzie, McLean, Mercer, Mountrail, and Ward Counties. It is home to members of the Three Affiliated Tribes (Mandans, Arikara, and Hidatsa). The reservation had a 1980 Indian population of 2,640, an increase of 150 percent over 1970. Some of this increase was due to return migration of Tribal members. However, conversations with Tribal representatives (1986) indicate the increase was not as great as indicated because the 1970 census resulted in an undercount of Indians on the Reservation. The majority of the Fort Berthold Indians live in the McKenzie and Mountrail County portions of the Reservation. Standing Rock Indian Reservation, which is home to the Standing Rock Sioux, is located directly southeast of the study area in Sioux County, North Dakota and Carson County, South Dakota. This reservation had a 1980 Indian population of 4,800, an increase of 64 percent over 1970. On both Reservations, the Indian population comprises about 50 percent of the total Reservation population (USDC 1974, 1982a; Council of Energy Resource Tribes 1983; Spotted Bear 1986; Dean 1986).

Employment and Earnings

Data for 1979 and 1984 show services, government, retail trade, and farming and to be the main sources of employment in the impact area. These four sectors of the economy account for nearly 70 percent of the total employment in 1984 with services contributing 22 percent, government 18 percent, retail trade 16 percent, and farming 13 percent. In 1984, five percent of the work force was engaged in mining (including oil and gas). Employment in the impact area increased six percent from 1979 to 1984, compared to a three percent increase statewide. Mining employment increased 50 percent while construction decreased 15 percent, agriculture decreased 12 percent, and manufacturing decreased nine percent. Transportation and public utilities, services, and wholesale trade grew 28 percent, 24 percent, and 14 percent, respectively, during that time period.

The distribution of employment, by source, varies a great deal among the counties. In some rural counties such as Divide, Dunn, Grant, Sheridan and Slope, agriculture contributed more than 40 percent of the employment in 1984. In other areas that are more urban or where mining is occurring, such as Burleigh, Mercer, Stark, Williams, and Ward, the contribution of agriculture was less than 10 percent in 1984. The retail trade and service sources in Burleigh, Morton, Stark, Ward, and Williams contribute substantial proportions of employment because these counties contain the regional trade and service centers of western North Dakota. Government contributes nearly 10 percent in each county and over 20 percent in Burleigh and Ward. Some counties (Billings, Burke, Dunn, McKenzie, Stark, McLean, and Williams) received over 10 percent of their employment from the mining sector in 1984.

Increases in employment between the years 1979 and 1984 occurred in some counties while losses in employment occurred in most. Mercer County had an increase of 52 percent, Williams County 25 percent, McKenzie County 18 percent, Stark County 14 percent, Burleigh County 9 percent, and Ward County 4 percent. The sources that grew included mining, government, and services. Employment losses occurred in all other counties and ranged from less than 1 percent (Golden Valley, Bottineau) to more than 10 percent in Billings County. Loss in farming employment occurred in every county in the impact area. Some counties also sustained large losses from the government, construction, retail trade, and service sources.

In 1979 and 1984, government and services were the major sources of earnings in the impact area. In 1984, government and services each accounted for 18 percent of the earnings, agriculture accounted for 10 percent, and mining, construction, and retail trade contributed 9 percent each. Earnings in the impact area increased 52 percent from 1979 to 1984 (in current dollars) while they increased 46 percent for the entire state during the same time period. Mining, transportation, public utilities, and services all increased more than 90 percent. Construction showed the smallest increase, 16 percent.

The distribution of earnings, by source, varies among the counties. The majority of the counties derived the largest proportion of their earnings from agriculture while a few derive their largest proportion from mining or services. Changes in earnings from 1979 to 1984 ranged from little change in Grant County to increases of over 60 percent in McKenzie, Mercer, Renville, Stark, and Williams Counties. These increases were generally due to increases in agricultural or resource related activities (mining, construction) (USDC 1986).

Minerals Taxation

North Dakota has a coal severance tax and a coal conversion facilities privilege tax. The coal severance tax is based on the amount of coal mined. Twenty percent is distributed among coal-producing counties (and some adjacent counties that are affected), and 50 percent is used to supply loans and make grants to coal impacted cities, counties and school districts. The remaining 30 percent is deposited in the State General Fund. In FY85 the coal severance tax generated 25.4 MM dollars in revenue.

The coal conversion facilities privilege tax is based on the amount of electricity or gas produced. The tax is distributed, in part, to the county in which the plant is located. Receipts in FY85 were approximately 12.7 MM dollars (North Dakota Tax Department 1984, 1985).

Payments in Lieu of Taxes

Payments in Lieu of Taxes (PILT) are made annually by the Federal government to counties containing Federal acreage which qualifies for these payments. Payments are designed to supplement other Federal land receipt sharing

payments which local governments may receive. North Dakota counties containing BLM land received $457,732 in payments in FY85. These payments were based on 1.5 MM acres of federal land of which 4.5 percent was managed by BLM. PILT vary from year to year even though acreages remain relatively constant because payments are made only if sufficient funding is made available through Congressional legislation and because they are partially based on other payments (which vary from year to year) received by local governments (USDI 1980, 1984, 1985a).

History of Resource Development

In the past 10 years, western North Dakota has undergone a boom and bust cycle in oil and gas exploration and a boom and bust in power plant construction. The rapid increase in oil and gas employment began in the midseventies and peaked in 1981 with the employment of 9,380 people statewide (USDL 1986). At that time, there were 130 drilling rigs and nearly 80 seismograph crews operating in western North Dakota (Chase and Leistritz 1983). By 1984, oil and gas employment had declined to 5,780, a decrease of about 38 percent. The majority of the decline represented decreases in exploration. Statewide employment in the coal industry increased slowly and steadily from 1970 to 1981, plateaued for 2 years and then increased slightly in 1984. Coal employment increased from 530 in 1970 to 1280 in 1984. Construction employment, much of it power plant-related, peaked at 17,320 in 1983 with coal-related power plant construction. Construction employment was expected to decline to about 12,000 in 1985 as power plant construction ceased (Job Service North Dakota FY86).

Communities in Mercer, Oliver, and McLean Counties have undergone changes in their social makeup or organization in the recent past because of coal-related development within the region (USDI 1982a). The successful integration of energy workers into communities in these counties, as well as in nearby Bismarck-Mandan, has expanded the social and cultural bases of the towns and has provided a more diversified economy for the area as a whole. Because of this growth, some of the social processes and structures and the administrative experience necessary to deal with development issues already exist in these communities. In a few cases, coal mines and facilities have been planned and/or constructed only to be scaled back or not built at all. Beulah in Mercer County may face a bust situation because the Great Plains Gasification Project has lost much of its government backing and the price of synthetic fuel is uneconomical at this time (Rudolph 1985).

The oil and gas activity of the last decade has caused population booms in many communities which led to the expansion of their economic and social environment (USDI 1982). In some communities a bust followed due to the decline in oil and gas exploration. Oil and gas activity has been concentrated in Williston in Williams County and Dickinson in Stark County. Other communities such as Belfield in Stark County, Killdeer in Dunn County, Watford City in McKenzie County, Tioga in Williams County and Bowman in Bowman County have also experienced some oil and gas related growth.

Fort Berthold Indian Reservation has not experienced on-Reservation coal development. Impacts from off-Reservation coal development have been limited to employment at the Great Plains Coal Gasification Project. Reportedly 40-75 Tribal members have obtained employment at the project; some of these members have relocated to the Beulah area to be nearer their place of employment. Oil and gas exploration has occurred on the Reservation since the 1950s. Exploration activity has recently declined. Some Tribal members have obtained steady oil and gas employment on and off the Reservation (Spotted Bear 1986, Dean 1986).

Standing Rock Reservation has not experienced coal development on the Reservation or been impacted by off-Reservation coal or oil and gas development. A few Tribal members attempted to obtain employment at area coal mines and facilities; none were hired. There has been some exploration for oil and gas on the Reservation and a few Tribal members have obtained jobs with the crews that worked on the Reservation (Murphy 1986, Marshall 1986).

Social Well-Being

In urban Burleigh, Morton, Stark, Williams, and Ward Counties, the data indicate the positive features of high levels of physicians per person, education, income, housing with plumbing for exclusive use (a housing quality indicator), and a high proportion of the population in the working age groups (18 to 64 years), compared to the rural areas. Negative features include higher divorce and crime rates (indicators of social stress) and more rapid loss of agricultural land (USDC 1982b, 1984).

In the rural areas, levels of physicians per person, education, income, housing with plumbing for exclusive use and the proportion of the population in the working age group are generally lower than in the urban areas. However, crime rates and divorce rates are also lower and agricultural land is being lost at a slower pace. Therefore, both the urban and rural areas offer positive and negative factors.

It should be noted that even if particular statistics indicate a low level of social well-being, the residents may not perceive their situation as such. Location and lifestyle may be more important to residents than services or economic opportunities. In fact, residents in small towns in western North Dakota are generally satisfied with the level of services offered (USDI 1982).

Social well-being indicators on the Fort Berthold and Standing Rock Reservations indicate the Indian residents have significantly higher levels of poverty than the study area as a whole. Family incomes are much lower, resulting in higher proportions of the populations having incomes below the poverty level, much higher unemployment rates, and a higher number of housing units lacking plumbing for exclusive use. In addition, a lower proportion of the Reservation populations are in the working age groups (18 to 64 years) and the proportions of the populations completing high school are low (USDC 1983c).

Attitudes Toward Resource Development

Very little attitudinal information has been collected on resource development in western North Dakota since the early 1980s. One statewide study conducted for the North Dakota Lignite Council in the spring of 1985 indicated a large majority of the respondents felt the coal industry has a positive effect on the state's economy and that increased use of the State's lignite resources would be beneficial to North Dakota. Another study conducted in the spring of 1986 (North Dakota Centennial Commission 1986) indicated a majority of the respondents felt conservation of

natural resources and protection of the natural environment, as well as reducing unemployment and increasing job variety, were high priorities. These surveys tend to verify earlier studies (USDI 1982) which indicated that a large segment of the population of the region favored some level of energy development but often qualified this approval. Concern for the protection of agricultural lands and some guarantee of reclamation potential were frequently listed as prerequisites for approval. Job opportunities generated by development and expansion of local economies were most often cited as reasons for favoring coal development. Many residents, of smaller communities in particular, were concerned about the health of their local business centers and wanted to see the economic base of the area expanded (USDI 1982).

The residents of the rural portions of affected counties were more apt to express opposition to development (USDI 1982). Their concern for the conservation of agriculture and the protection of land, air and water quality both on and offsite was often very strong. Some area farmers and ranchers have organized in opposition to development. They question the need for coal leasing and the fairness of BLM's surface owner consultation process, as well as expressing environmental concerns. In addition, negative impacts of development such as increased population levels, crowding of schools and increased incidences of crime were frequently given by small town residents as reasons for opposing coal leasing (USDI 1982).

Interviews with representatives of both the Fort Berthold and Standing Rock Indian Reservations indicate increased employment for Tribal members is one of their major objectives. If off-Reservation coal development were to occur, Tribal members would likely try to obtain employment at the mines and facilities. Concerns regarding off-Reservation coal development include air quality and problems with reclamation (Spotted Bear 1986, Murphy 1986).